SARGENT

Fifteen Mechanical Problems Reasons for their Existence and their Solution

Mechanical Engineer

M. E.

1915

FIFTEEN MECHANICAL PROBLEMS
REASONS FOR THEIR EXISTENCE AND THEIR SOLUTION

BY

CHARLES ELLIOTTE SARGENT

B. S., University of Illinois, 1886

THESIS

Submitted in Partial Fulfillment of the Requirements for the

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1915

UNIVERSITY OF ILLINOIS

THE GRADUATE SCHOOL

May 24, 1915

I HEREBY RECOMMEND THAT THE THESIS PREPARED UNDER MY SUPERVISION BY

Charles Elliotte Sargent

ENTITLED Fifteen Mechanical Problems; Reasons for Their Existence and Their Solution

BE ACCEPTED AS FULFILLING THIS PART OF THE REQUIREMENTS FOR THE DEGREE OF Mechanical Engineer

In Charge of Major Work

C. R. Richards

Head of Department

Recommendation concurred in:

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Committee on Final Examination

FIFTEEN MECHANICAL PROBLEMS.

REASONS FOR THEIR EXISTENCE AND THEIR SOLUTION.

1. To construct an internal combustion engine so that it will have as uniform a turning moment as a single cylinder double-acting steam engine.

11. To increase the efficiency of an internal combustion engine by increasing the working stroke, thereby converting more heat into work and incidentally eliminating the "bark".

111. To operate the intermittent cam driven valve motion of slow rotative speed internal combustion engines with eccentrics in order to obtain a high rotative speed necessary for driving direct connected electric generators.

1V. To perfect a mechanism for starting internal combustion engines with compressed air, which is automatically thrown out of commission when air is turned off, and into commission when air is turned on, and which can only wear when engine is starting.

V. To construct a device which will, without moving mechanical parts, (a stipulation laid down by Fire Underwriters in making rules for the installation of sprinkler apparatus) indicate a change in head of one pound pressure or less, by lighting a lamp or ringing a bell.

V1. To bring out an instrument which will indicate the angular velocity variation of a flywheel during a revolution, a mechanical umpire, as it were, between engine and generator builders when parallel operation must be attained.

V11. To devise an attachment for steam, air or gas pipes which would indicate the pounds avoirdupois of steam, air or gas flowing through, irrespective of pressure, i.e., a Flow Meter.

V111. To construct a gas driven air compressor which would be self-contained, simple in construction, cheap to build, which would require a minimum amount of floor space, and have a high mechanical and thermal efficiency.

1X. To redesign a rotary valve vacuum cleaning machine which could be manufactured for 50% less, which could not wreck itself with entrapped water, and which would have an increased capacity of 75%.

X. To develop a centrifugal governor for a Single Phase Linotype Motor which would allow it to start as a splitphase repulsion type and to change at a predetermined speed to an induction type.

Xl. To provide a gas calorimeter for commercial work that can be manipulated by one person, which will permit of continuous operation, and in which the personal error of observation and manipulation is eliminated.

Xll. To build a self-adjusting universal air jack for barring over flywheels of gas or steam engines, enabling a man or boy to do the work of three or four men in one quarter of the time.

Xlll. To make a thermostat for a fireless electrically heated cooker which will automatically open the circuit when a predetermined temperature is reached, which will not oxidize, corrode or deteriorate with use.

XlV. To have a portable unbreakable, unspillable, draft-gage with a six inch range which can be read to one hundredth of an inch to go with testing outfit.

XV. To construct a variable speed transmission by which the driver at a constant speed can drive the driven member either direction from no revolutions per minute to its maximum speed, without end thrust, side thrust or short leverage at low speed and maximum power, which are indigenous to the ordinary friction drive.

PROBLEM 1.

PROBLEM
1.

To construct an internal combustion engine so that it will have as uniform a turning moment as a single cylinder double-acting steam engine.

REASONS FOR SUCH A PRIME MOVER.

At the Columbian Exposition in Chicago in 1893 there were exhibited six or eight internal combustion engines, the largest of which was a 35 H.P. Most of these represented the sizes furnished by the Otto Gas Engine Company of Philadelphia, and as the Otto four cycle patent had not expired, the other small engines exhibited were of the two cycle Marine engine type.

The governing of the four cycle type was by the hit and miss method, a system conducive to thermal efficiency, but not to a uniform turning moment.

As a single cylinder, single acting four cycle engine gets under full load, an impulse in two revolutions, if the hit and miss governor were in operation, it would get an impulse every two, four, six or eight revolutions, depending on the load and the mechanical efficiency of the engine. It is evident that with such spasmodic impulses this type of prime mover would not be satisfactory for dynamo driving.

Natural gas wells were being opened every day, gasoline, a by-product of kerosene could be purchased for about four cents per gallon, and producer gas had been generated successfully in Europe, where natural gas at that time was unknown.

While it was generally admitted that the thermal efficiency of internal combustion engines was from two to three times the efficiency of a steam engine, on account of their supposed limited horse power and irregular torque, power

users had but little faith in their ultimate success.

As the four cycle single acting gas engine had no compression on its outward stroke, and a compression every other revolution only on its opposite stroke, the author believed that single cylinder internal combustion engines would never be commercial in large sizes, and in fact, did not believe that single acting pistons in multi-cylinder engines of large capacities would be the solution of the gas engine problem. Having placed over two hundred horizontal steam engines in Chicago buildings, the author was so wedded to this type that a horizontal gas engine with as many impulses as a simple steam engine seemed to be the rational solution of the problem.

In 1895 drawings of a tandem double-acting gas engine to give an impulse every stroke were made under the author's direction, and in 1896 the first tandem double acting gas engine to the author's knowledge, was run on its own power. This engine was equipped with rotary stove damper valves of soft cast iron, which might have lasted twenty-four hours if engine had been run that long. While the engine as a whole was a miserable failure, the piston rods, working one-quarter of the time in a temperature averaging 2400° F. showed no signs of deterioration or overheating, and the success of the tandem double acting gas engine was assured.

SOLUTION.

While the Westinghouse Machine Company, which had just begun to make two and three cylinder vertical gas engines, stated most emphatically in their catalog that "on account of the high temperature of combustion, piston rods and stuffing boxes were impossible in gas engines", the author was studying the gas engine problem, and so far perfected the tandem double-acting gas engine (Fig.1) that five years later he had one belted to an electric generator, making as satisfactory light as the high speed Ideal engine in the same power plant, which the author had installed seven years before.

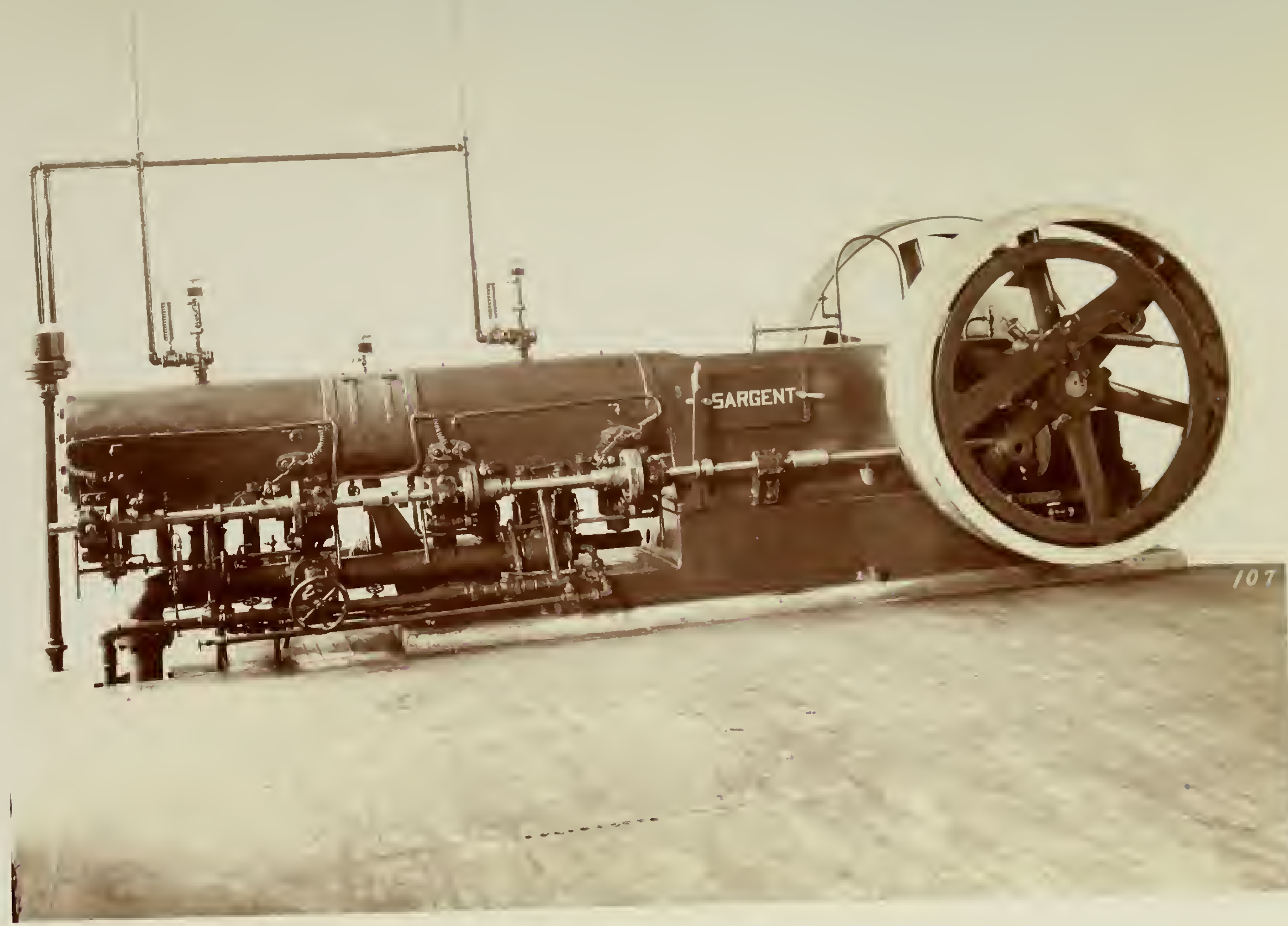


Fig. 1

The angular velocity variation of the belt wheels, as determined by the Anglemeter (Problem VI) was no greater with proper firing and mixture than the single cylinder steam driven engine, heretofore mentioned.

On account of having a compression every stroke, to bring the moving parts to rest, the engine ran smoothly, even at a piston speed of seven hundred feet per minute, which was about a hundred feet per minute higher than steam engine practice.

While the double-acting tandem construction insures four times the power from the same crank and cylinder diameter, and a much better turning moment conducive to uniform speed, the substitution of a cutoff governor which varied the M.E.P. with the load, for the hit and miss method so common on single acting engines, contributed greatly to the quiet and smooth running of the engine.

The problem in the author's opinion was solved, but of the many internal combustion engines shown at the Paris Exposition in 1900 there was not a single double-acting tandem engine, but there was one single cylinder, single acting 600 horsepower engine, which indicated the possibilities in cylinder construction.

Today, tandem double-acting, single and twin, gas engines are the only types found in large sizes, and they are driving, without cross currents or undue heating, alternators in parallel, a feat hardly anticipated when the 35 horsepower Otto engine, shown at the Chicago World's Fair was as "large as explosion engines could be made".

PROBLEM 11.

PROBLEM
11.

To increase the efficiency of an internal combustion engine by increasing the working stroke, thereby converting more heat into work and incidentally eliminating the "bark".

ARGUMENT.

The engineer who realizes the economy in cutting off the steam in a steam cylinder after the piston has made one quarter of its stroke, can hardly reconcile the red hot exhaust pipe and the high terminal pressure of an internal combustion engine as indigenous to a prime mover two or three times more efficient than a steam engine.

The apparent waste of heat and energy seemed to the author unpardonable when he realized that if the heat were converted into work, the efficiency of the gas engine would be increased, the distortion and deterioration of the exhaust valves and piping would be eliminated, and the annoying noise of release would be overcome.

Familiarizing himself with the Atkinson cycle, which with a terminal pressure of twenty-five pounds absolute, showed the highest efficiency at that time attained by a restrained piston engine, the author believed that a higher efficiency could be secured with a lower terminal pressure and without the grasshopper motion of the Atkinson engine.

To get a more complete expansion of the burning gases in an ordinary reciprocating engine, it would be necessary to expand the ignited charge before release to a volume greater than the volume of the cold gases just as compression began. A throttled charge with early ignition would secure a low terminal pressure, but the back pressure due to the wire drawing during the

induction stroke, would offset any gain in economy during the working stroke.

The ordinary gas engine at this time, at full load, compressed a cylinder full of combustible mixture, ignited it and at the end of the working stroke when the temperature of the burning charge was 1500° F. released it by opening the exhaust valve. From a careful analysis of a normal diagram, it was estimated that by carrying the expansion sixty per cent further, the terminal pressure would drop from fifty to sixty pounds, to eighteen to twenty pounds absolute, and the additional area in the diagram would mean an increased M.E.P. for the same amount of fuel.

SOLUTION.

At the time this problem was considered, intake valves were opened by suction, a method long since abandoned except on the cheapest engines, and to provide a way of cutting off the inlet charge at some predetermined point of the stroke depending on the load, a valve motion (Specification #752303) embodying a poppet valve to hold against compression and explosion, and a piston cutoff valve to control the intake was designed, tested and found to fulfill its mission.*

Driven by a floating lay shaft which advanced the time of cutting off the induced charge as well as the time of ignition, which should be earlier as the mixture gets weaker and compression less, this valve motion in conjunction with the tandem double-acting gas engine solved the problem, and even the 10" x 20", 50 B.H.P. engine (Problem 1) was at that time the most economical internal combustion prime mover that had ever been produced.

Diagrams showing about twenty-four per cent more area than diagrams from engines which released at the same point compression began; the exhaust temperature at full load was about 500° F. and the pressure at release twenty to twenty-five pounds absolute.

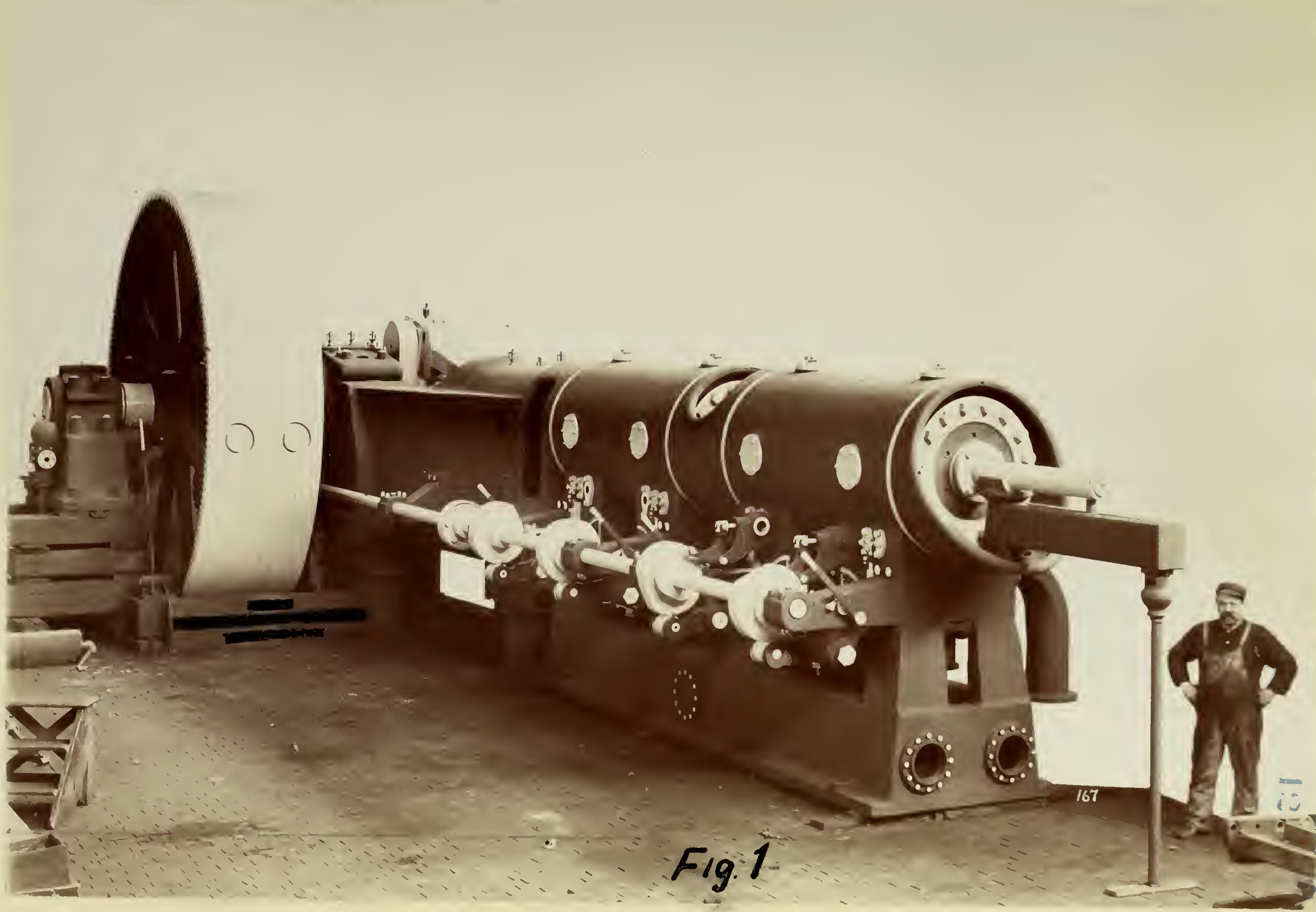


Fig. 1

Of four complete tests, the average available B.t.u. per B.H.P. hour at full load were 8705, which equals $(\frac{2545}{8705})$ a thermal efficiency of 29.23% seldom excelled by a Diesel engine.

Larger engines (Fig.1) with twenty-five inch cylinder diameter, 48" stroke, were constructed on the same lines, i.e., with a cam driven valve motion and a flywheel inertia governor, which varied the time of cutoff and ignition with the load. These engines at 100 R.P.M. and 800 feet piston speed, for belt drive, so fulfilled the function for which they were constructed, that a change in design was never anticipated, yet the direct connected electric generator was destined to raise both the rotative and piston speed of this type of prime mover.

*For a complete description of this engine see Transactions of the American Society of Mechanical Engineers 1901, Volume 22.

No. 752,303. PATENTED FEB. 16, 1904.

C. E. SARGENT.

VALVE FOR INTERNAL COMBUSTION ENGINES.

APPLICATION FILED APR. 27, 1900.

NO MODEL. 3 SHEETS—SHEET 1.

Fig. 1.

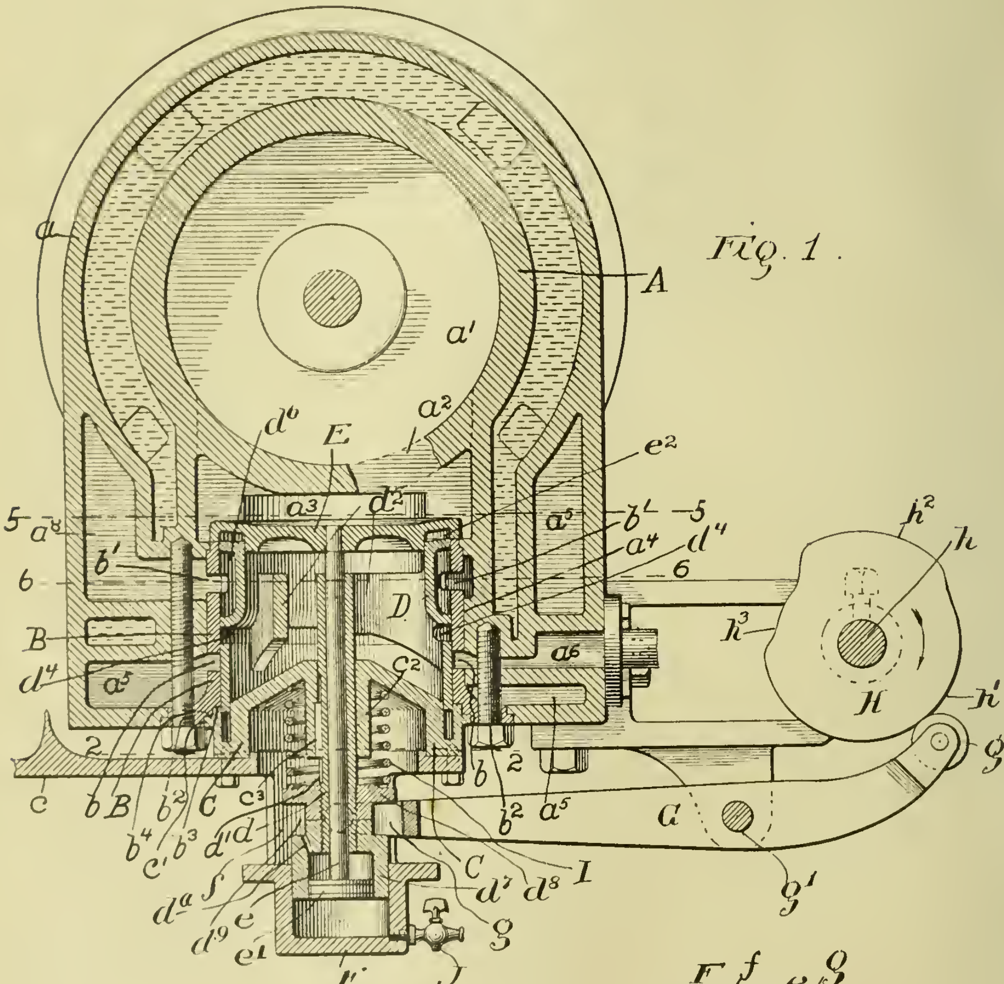
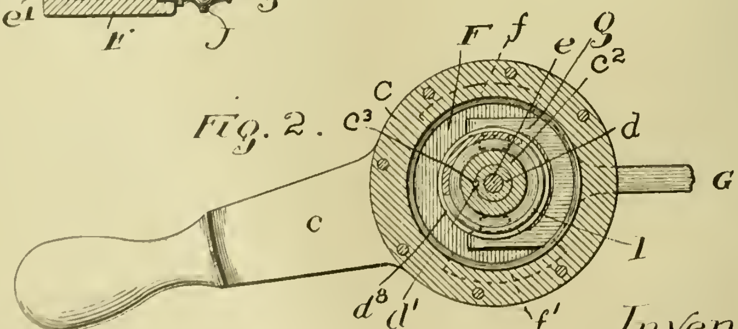


Fig. 2.



Witnesses:
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S. Bliss.

Inventor:
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No. 752,303. PATENTED FEB. 16, 1904.

C. E. SARGENT.

VALVE FOR INTERNAL COMBUSTION ENGINES.

APPLICATION FILED APR. 27, 1900.

NO MODEL. 3 SHEETS—SHEET 2.

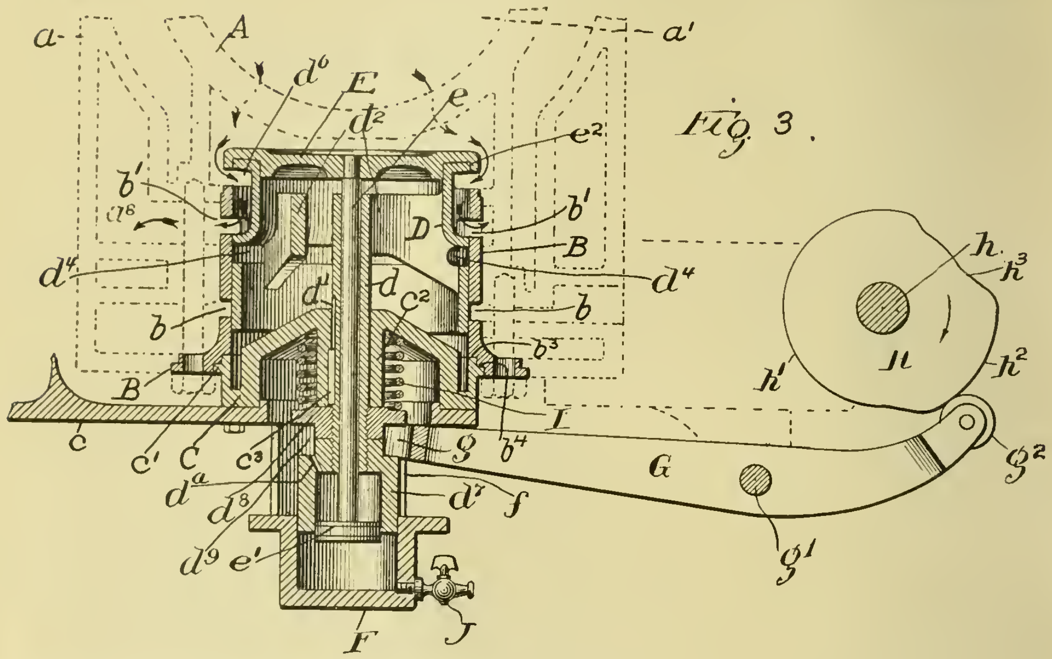

Fig. 3.

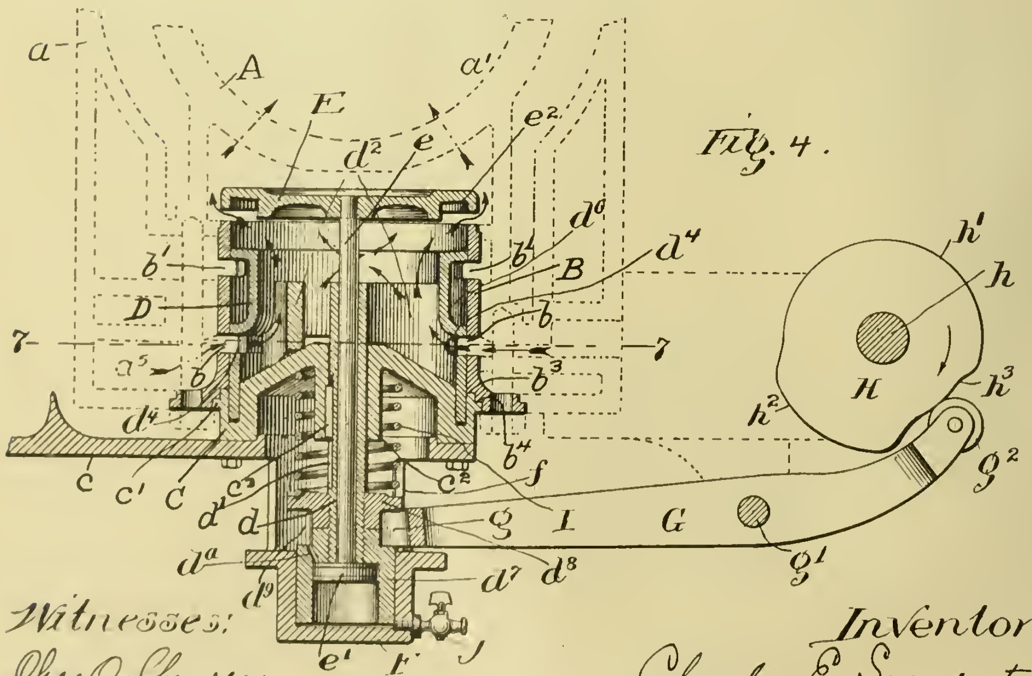

Fig. 4.

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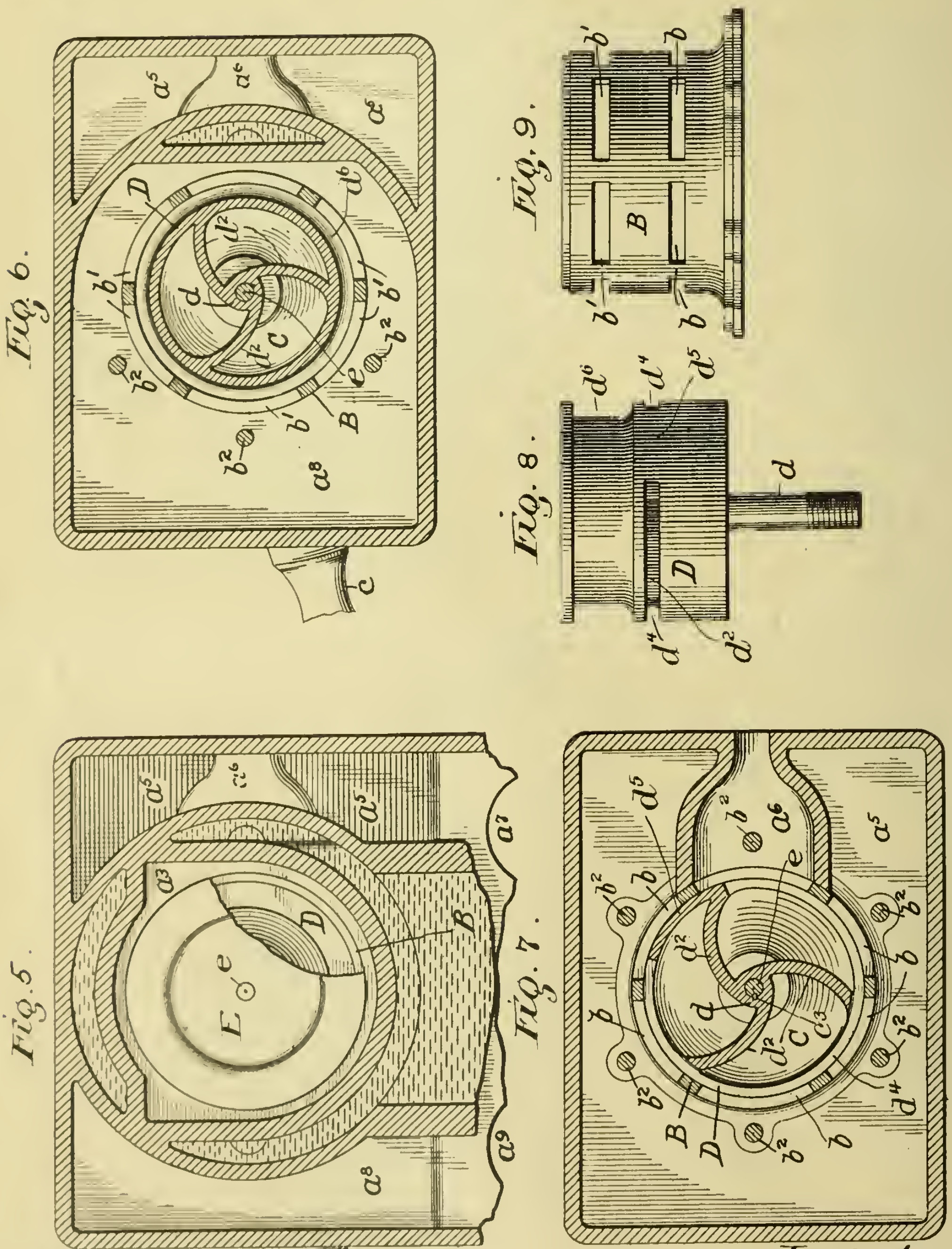
No. 752,303. PATENTED FEB. 16, 1904.

C. E. SARGENT.

VALVE FOR INTERNAL COMBUSTION ENGINES.

APPLICATION FILED APR. 27, 1900.

NO MODEL. 3 SHEETS—SHEET 3.



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No. 752,303. Patented February 16, 1904. 18

UNITED STATES PATENT OFFICE.

CHARLES E. SARGENT, OF CHICAGO, ILLINOIS, ASSIGNOR OF THREE-FOURTHS TO OLIVER S. LYFORD, OF NEW YORK, N. Y., AND CHARLES W. HILLARD, TRUSTEE, OF CHICAGO, ILLINOIS.

VALVE FOR INTERNAL-COMBUSTION ENGINES.

SPECIFICATION forming part of Letters Patent No. 752,303, dated February 16, 1904.

Application filed April 27, 1900. Serial No. 14,555. (No model.)

To all whom it may concern:

Be it known that I, CHARLES E. SARGENT, a citizen of the United States of America, residing at Chicago, in the county of Cook and State of Illinois, have invented certain new and useful Improvements in Valves for Internal-Combustion Engines, of which the following is a specification.

My invention relates to certain improvements in valves designed in connection with a valve intended for use in a class of internal-combustion engines in which the admission-ports are closed at some intermediate point in the first forward or admission stroke of the piston in order that in the working stroke the gases may be allowed to expand down to approximately atmospheric pressure, thereby converting the heat into work instead of allowing it to escape in the exhaust. In these engines the charge is drawn in by the suction of the piston during a portion of the first forward stroke. The admission-ports are then closed, and during the remainder of the forward stroke the piston expands the charge, creating a partial vacuum within the cylinder, the suction of which aids in drawing the piston back, returning to the engine the power which has been employed in the expansion of the charge. When the piston reaches the point of cut-off on the first backward stroke, the compression above atmospheric commences and is continued up to a predetermined pressure, depending upon the per cent. of clearance. The charge is then exploded and drives the piston down to the cut-off point in the ordinary manner, after which it continues to drive the piston to the end of its stroke, and the gases expanding down to atmospheric pressure convert the heat into work, thereby utilizing after passing the cut-off point the pressure which is usually wasted in the exhaust.

The object of the invention is to provide for the use of a single valve for each explosion-chamber, to operate the same by means of a single cam and a single cam-lever, so that the construction may be as simple as possible and also so that there may be but one irregularity in the inner contour of the cylinder to increase the radiating-surface thereof.

It is also the object of the invention to provide an improved method of varying the relative proportions of the ingredients consumed, also to make the various parts of the valve easy of operation, avoid clicking of the same, and to provide means whereby the valve may be put into a condition for opening without necessarily opening it, so as to make said opening dependent to a certain extent upon the pressure within the cylinder.

It is also an object of the invention to provide a simple and convenient balance for the weight of the valve adjustable to any desired force.

To such ends the invention consists in certain characteristics which will fully appear from the following description and be definitely pointed out in the claims.

In the drawings presented herewith, Figure 1 is a vertical section transverse to the axis of the cylinder of an engine. Fig. 2 is a horizontal section in line 2 2 of Fig. 1. Fig. 3 is a vertical section of the valve, showing the parts in a different position. Fig. 4 is a similar view showing the parts in a third position. Fig. 5 is a horizontal section in line 5 5 of Fig. 1. Fig. 6 is a horizontal section in line 6 6 of Fig. 1. Fig. 7 is a horizontal section in line 7 7 of Fig. 4. Fig. 8 is a side elevation of the piston portion of the valve; and Fig. 9 is a similar elevation of the casing in which said piston slides.

Referring to the drawings, A represents an ordinary cylinder-casting with water-jacket a, an interior cylindrical bore a', and a single valve-port a^2, arranged at the bottom and at one end of the cylinder and extending to the valve-chamber a^3. The valve-chamber contains a cylindrical bore a^4, in which is secured a bushing B. (Shown in side elevation in Fig. 9.) This bushing contains inlet-ports b, arranged around its periphery, and exhaust-ports b', also arranged around the periphery of the bushing and preferably parallel with the inlet-ports. These ports open into suitable passages in the casting, the inlet-ports b opening into the passage or chamber a^5 except at a limited portion thereof, (shown clearly in Fig. 7 and lettered a^6,) the limited portion being intended for the introduction of gas or other combustible material, and the chamber a^5 for the introduction of air which comes in through openings, portions of which are shown at a^7 in Fig. 5. The exhaust-ports b' empty into a chamber a^8 and the exhaust escapes therefrom through an opening a^9, also partially shown in Fig. 5. The bushing is shown as held in place by nuts b^2, which also hold in place a rotatable cap or plug C, provided with a handle c to turn it. The cap is circular in form and rests upon shoulders b^3 b^4 on the bushing, a circumferential flange c' resting upon the latter shoulder and being engaged by the nuts b^2 to hold the cap in place. The cap is preferably hollow and coned upwardly and also has a central boss c^2, in which is guided a hollow stem d of a piston-valve D, the stem and boss having a spline connection, (shown at c^3 d'.) This connection gives the piston-valve a vertical movement in the cap, but causes the valve to rotate with the cap when the latter is turned by the handle c. The piston-valve is a hollow shell connected to the stem by radial spokes or wings d^2. It is slotted circumferentially at d^4 to register in a certain position with the inlet-openings b of the casing. The slot does not extend quite around the valve, being interrupted by a solid portion d^5, which may be brought by the rotation of the valve before the openings in the casing which connect with the air-chamber or before the opening which connects with the chamber a^6, through which the combustible part of the charge is taken in. By this means the relative size of the openings which draw in air and gas or other material may be changed to admit varying proportions of the same. The upper portion of the valve contains an outside peripheral channel d^6. (Clearly shown in Fig. 8 and in the various sections.) This channel is of sufficient width to connect the exhaust-ports b' with the interior of the valve-chamber, as is shown in Fig. 3, when the piston-valve is in its upper position. In this position the exhaust is allowed to escape from the cylinder through the chamber a^8. In the intermediate position of the valve shown in Fig. 1 this groove is lowered entirely within the casing to cut off the exhaust, and the inlet-openings of the valve have not been lowered far enough to reach the inlet-ports b of the casing. A further downward movement of the valve brings it into the position seen in Fig. 4, in which the inlet-ports are opened into the interior of the valve.

A puppet-valve E seats upon the top of the casing and has a stem e extending through the hollow stem of the piston-valve and terminating in a smaller piston e' within a hollow nut d^7, screwed upon the lower end of the piston-valve stem and guided within a cylindrical cup F, supported by brackets f f', extending downward from the cup C. This nut d^7, together with another just above it, d^8, embrace between them an annular groove d^9, within which is fitted a fork g upon the end of a lever G, pivoted at g' to the frame and bearing at its opposite end a roller g^2, running upon a cam H, fast upon a cam-shaft h, journaled in suitable bearings on the cylinder of the engine. A spring I is interposed between the nut d^8 and the cap C and tends to draw the forked end of the lever G down to guide the roller upon the surface of the cam. The surface of the cam is divided into three concentric portions h' h^2 h^3, the portion h' corresponding to the intermediate position of the piston-valve shown in Fig. 1, the portion h^2 corresponding to the highest position of the piston-valve shown in Fig. 3, in which the exhaust-port is open, and the portion h^3 corresponding to the lowest position of the piston-valve shown in Fig. 4, in which the inlet-ports are open. The puppet-valve E acts as a closure both for the bushing of the valve-casing and for the piston-valve when the latter is sufficiently raised.

The lower face of the puppet-valve contains an annular groove e^2, adapted to receive the upper end of the piston-valve, as seen in Fig. 3, and said groove is preferably made to fit closely, so that an air-cushion may be obtained to avoid the clicking of the two valves when they come together. Furthermore, the inner wall of the groove laps over the inside surface of the piston-valve when the latter is in its intermediate or normal position, as seen in Fig. 1, causing the puppet-valve to cut off connection between the cylinder and the interior of the piston-valve slightly in advance of the seating of the puppet-valve upon the bushing. The nut d^7 has a small perforation at d^a to admit atmospheric pressure above the piston e', and the air within the chamber below acts as a spring to assist in the raising of the puppet-valve when the piston-valve is in the position seen in Fig. 4, in which the capacity of the chamber is reduced by the lowering of the nut. A petcock J provides means for allowing air to escape or to enter, as the case may be, to adjust the pressure within the chamber.

The wings or bridges d^2 are curved from the stem to the valve, so as to prevent them from forming rigid struts between the stem and the outer wall of the valve. This is done so that the expansion and contraction of the wings need not necessarily force the outer wall of the valve out of round, but may be compensated for by an increase or decrease of the curvature of the wings.

The valve, as shown, is arranged for and adapted to a four-cycle explosive-engine, in which the admission of the charge is cut off at part of a stroke of the piston. Looking first at Fig. 4, the parts are shown in a position in which the charge is entering the cylinder. The roller is resting on the lowest part of the cam, allowing the forked end of the lever G to drop, which permits the spring I to draw down the piston-valve, reduces the capacity of the chamber in the cup F, causing an upward pressure upon the piston e', and assisting the raising of the puppet-valve E, so that the entire weight of said valve need not necessarily be overcome by suction from within the cylinder. The position of the parts remains the same until the roller leaves the part h^3 of the cam. When the cam has advanced in the direction of the arrow sufficiently to bring the part h' under the roller, the piston-valve has risen sufficiently to close the inlet-ports and increase the capacity of the chamber within the cup F, as seen in Fig. 1, removing the upward pressure upon the piston e' and at the same time cutting off the supply of gas and air, so that the puppet-valve seats itself by its own gravity or by suction upon the piston e' if the tension of the air within the chamber is such as to assist the downward movement, and this position continues during the remainder of the forward stroke of the piston, all of the backward or compression stroke of the engine, and all of the second forward or working stroke. During the remainder of the first forward stroke the expansion of the charge caught within the valve may cause the puppet-valve to rise from time to time; but its return cuts off the flow of gas before the valve seats, so that no chattering occurs. At the end of the working stroke the cam H has advanced sufficiently to bring the highest part h^2 beneath the roller, raising the piston-valve upward against the puppet-valve and carrying the latter with it against the pressure within the cylinder into the position seen in Fig. 3, where the exhaust-ports are connected with the interior of the cylinder and the exhaust flows into the exhaust-chamber and thence into the atmosphere. This completes the cycle, and as the roller runs off of the part h^2 of the cam onto the depression h^3 the parts resume the original position (shown in Fig. 4) for the admission of a new charge.

Much of the novelty herein more or less completely disclosed is claimed in my pending applications Serial Nos. 14,553, 14,556, 131,063, and 131,309.

The principal features of the invention are not necessarily dependent upon the exact devices and forms of arrangement thereof, and for this reason I do not limit myself to the specific details of construction above described.

In the claims I shall for brevity refer to the combustible portion of the charge as "gas," meaning thereby to include any combustible material which may be used in place of the gas in a device of this sort.

I claim as new and desire to secure by Letters Patent—

1. The combination with a combustion-cylinder and inlet and discharge ports therefor, of a reciprocating piston-valve provided with channels adapted to connect said ports, respectively, with the cylinder as the valve reciprocates, and a valve arranged to close one of said channels while the other is open.

2. In a device of the class described, the combination with a valve-chamber provided with inlet and exhaust ports, of a piston-valve therein provided with an outside channel adapted in a given position of the valve to connect the exhaust-port with the cylinder and with an inside channel adapted in a given position of the valve to connect the inlet-ports with the cylinder, and having portions adapted in either of said positions to cut off the other port, and a puppet-valve adapted to close the inner channel when the outside channel is open substantially as set forth.

3. In a device of the class described, the combination with a piston-valve provided with channels adapted respectively to govern the inlet and exhaust ports, of a puppet-valve adapted to close one of these channels when the other is open; substantially as described.

4. The combination with the combustion-cylinder, of a reciprocating valve arranged to open and close the inlet-port as it moves transversely with reference thereto to different positions, a second independently-movable valve carried by the first, arranged to cut off communication between the first valve and the cylinder and means for closing the second valve during the combustion of the charge.

5. In a device of the class described, the combination with a cylinder having a suitable valve-chamber, an exhaust-port and inlet-ports for air and combustible material respectively, of a valve having channels adapted to alternately connect the exhaust-port and the inlet-ports with the cylinder, said valve being capable of reciprocating movement in one direction to open and close the ports and in another direction to vary the relative size of the inlet-ports; substantially as described.

6. In a device of the class described, the combination with a cylinder provided with a cylindrical valve-chamber having a suitable exhaust-port and inlet-ports for the air and gas respectively, of a piston-valve fitted to said chamber having passages adapted to alternately connect the exhaust and inlet ports with the cylinder, means for moving said piston longitudinally to open and close the respective ports and means for moving it angularly to vary the relative size of the inlet-ports; substantially as described.

7. The combination with a hollow piston-valve, of a puppet-valve seating upon one end thereof, and provided with a groove adapted to receive said end and provide an air-cushion; substantially as described.

8. In a device of the class described, the combination with a piston-valve and a puppet-

valve of a stem for the puppet-valve and a piston upon the valve-stem within the chamber provided with means for varying its capacity by the movement of the piston-valve; substantially as described.

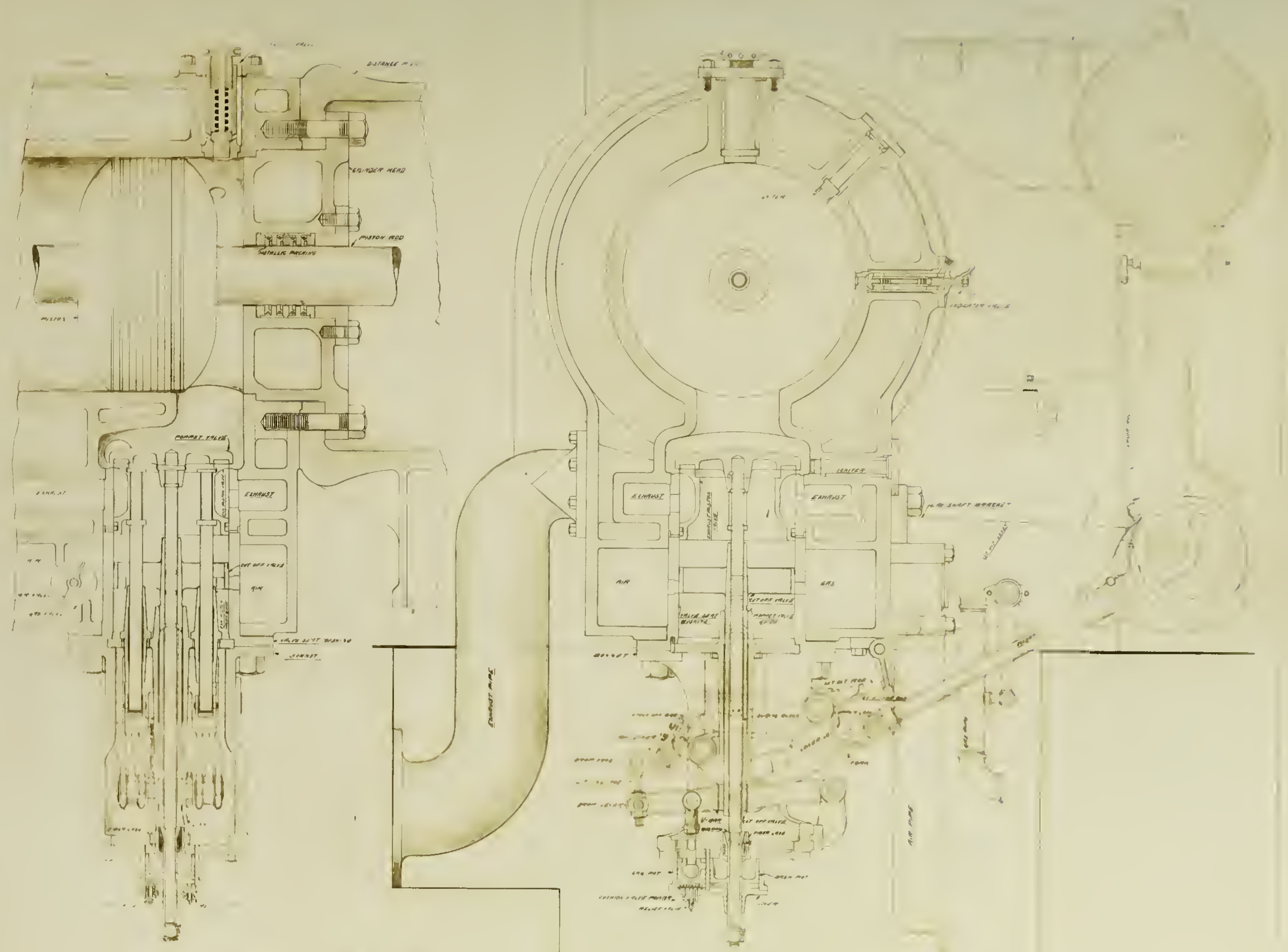
9. In a device of the class described, the combination with a suitable valve-opening and valve-seat, of a puppet-valve fitted to said seat and means for closing the opening prior to the seating of the valve, whereby the movements of the valve toward its seat are checked and chattering upon the seat is avoided; substantially as described.

In witness whereof I have hereunto set my hand, at Chicago, in the county of Cook and State of Illinois, this 19th day of April, A. D. 1900.

CHARLES E. SARGENT.

Witnesses:
CHAS. O. SHERVEY,
S. BLISS.

PROBLEM 111.



COMPLETE EXPANSION GAS ENGINE.

WISCONSIN ENGINE COMPANY.

CORLISS WIS.

Fig. 1

129_B

PROBLEM
111.

To operate the intermittent cam driven valve motion of slow rotative speed internal combustion engines with eccentrics in order to obtain a high rotative speed necessary for driving direct connected electric generators.

REASONS FOR SUCH A VALVE MOTION.

The distinctive feature of the valve motion of a complete expansion gas engine is the single port in bottom of cylinder and single poppet valve holding against compression and explosion pressure, which opens to let the exhaust out and closes and opens again to admit the charge, meted in by the piston valve and governor. The piston valve moves up to exhaust and down to admit requiring a double functioned cam following the contour of which rides the roller which times the valve opening and closing.

The valve motion of long stroke slow speed engines (Fig.1;Problem 11) is operated by such cams and satisfactorily as long as their perimeter speed does not exceed 400 feet per minute. For a high thermal efficiency, the author preferred and constructed engines with the cylinder diameter one half the stroke, but to meet the requirements of direct connected generators, even though at a slight sacrifice of efficiency, a shorter stroke and a higher rotative speed were desirable, and to operate the combination piston and poppet valves quietly and positively was the problem the author had to solve. Up to this time the poppet which acted as a check valve for the admission, but in no way controlled the quantity of the charge, was opened by suction during the induction stroke and tended to chatter with friction loads.

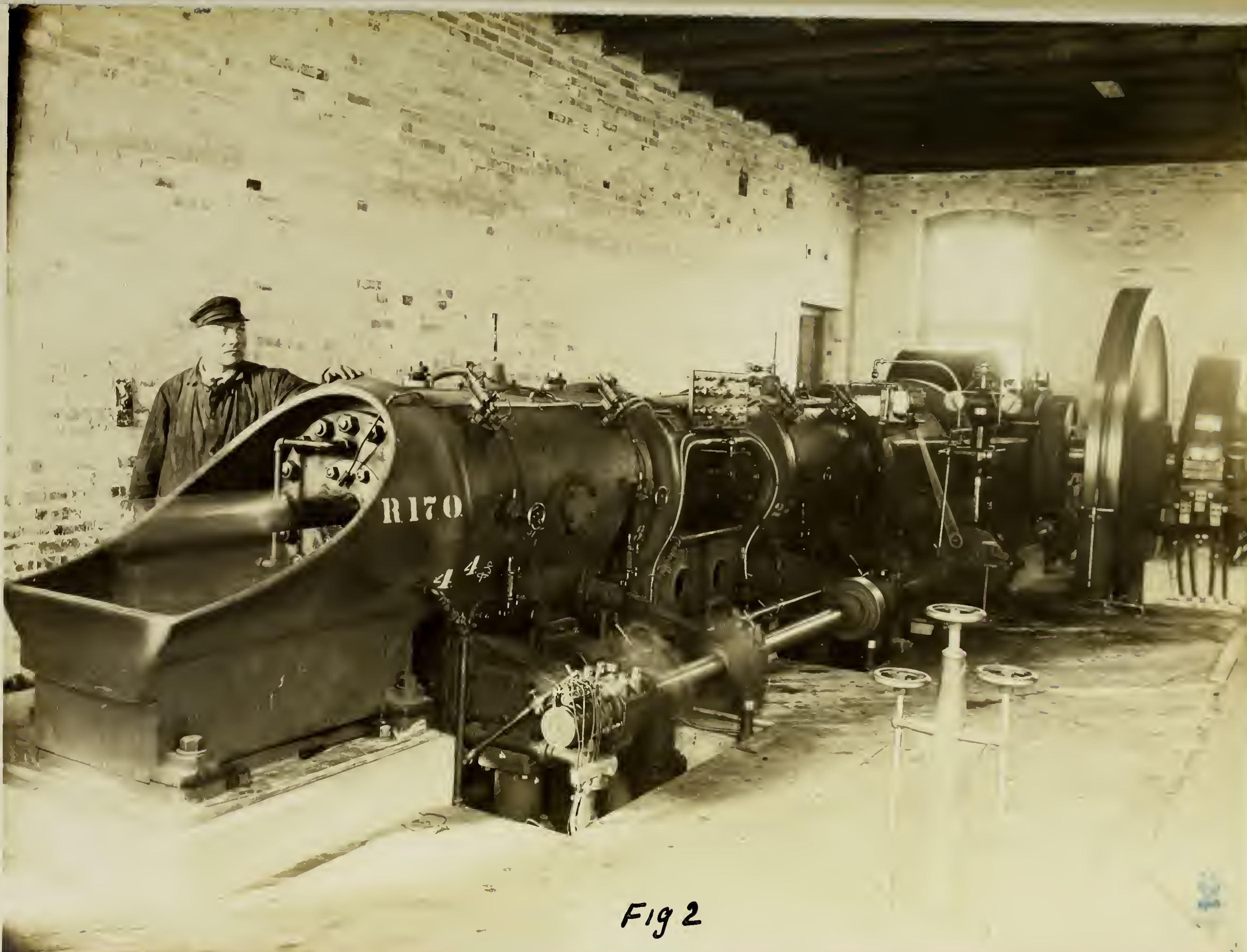


Fig 2

SOLUTION.

The solution of the problem provides for a positive movement of both piston and poppet valves at all parts of the cycle and a Corliss release gear timed by the governor and operated by a vacuum dash pot for closing the piston valve when cutoff takes place.

Figure 1 is a photograph of the valve motion, side and end sectional elevation, showing the eccentric drive, governor control and ease of dissembling.

Specifications #1072366 attached, show details of construction and the way the problem was solved. The closing of the poppet twice and the cutoff valve once during the cycle, by air pressure is conducive to quick and noiseless operation and long life.

That the solution met the requirements of the problem is evidenced by Figure 2, a three minute exposure or while the engine made six hundred revolutions with too little vibration to disturb a penny resting on its edge on the head end of cylinder.

In Figure 3 is clearly shown the single eccentric for each explosion chamber and the ignition timing commutator on the end of the half speed shaft.

A feature indigenous to all complete expansion gas engines is the ability to cut out one or more explosion chambers while engine is running, enabling a change of an igniter, or the maintaining of a higher thermal efficiency with light loads.

Figure 4 are diagrams taken from engine (Fig.3) running on about half load. The fat diagrams were taken when operating as a single acting tandem, and the lean diagrams when all four explosion chambers were in operation.

This eccentric driven valve motion has run for years without attention, yet on account of commercial and industrial problems there are probably but few, if any complete expansion gas engines in operation today. Steam turbines

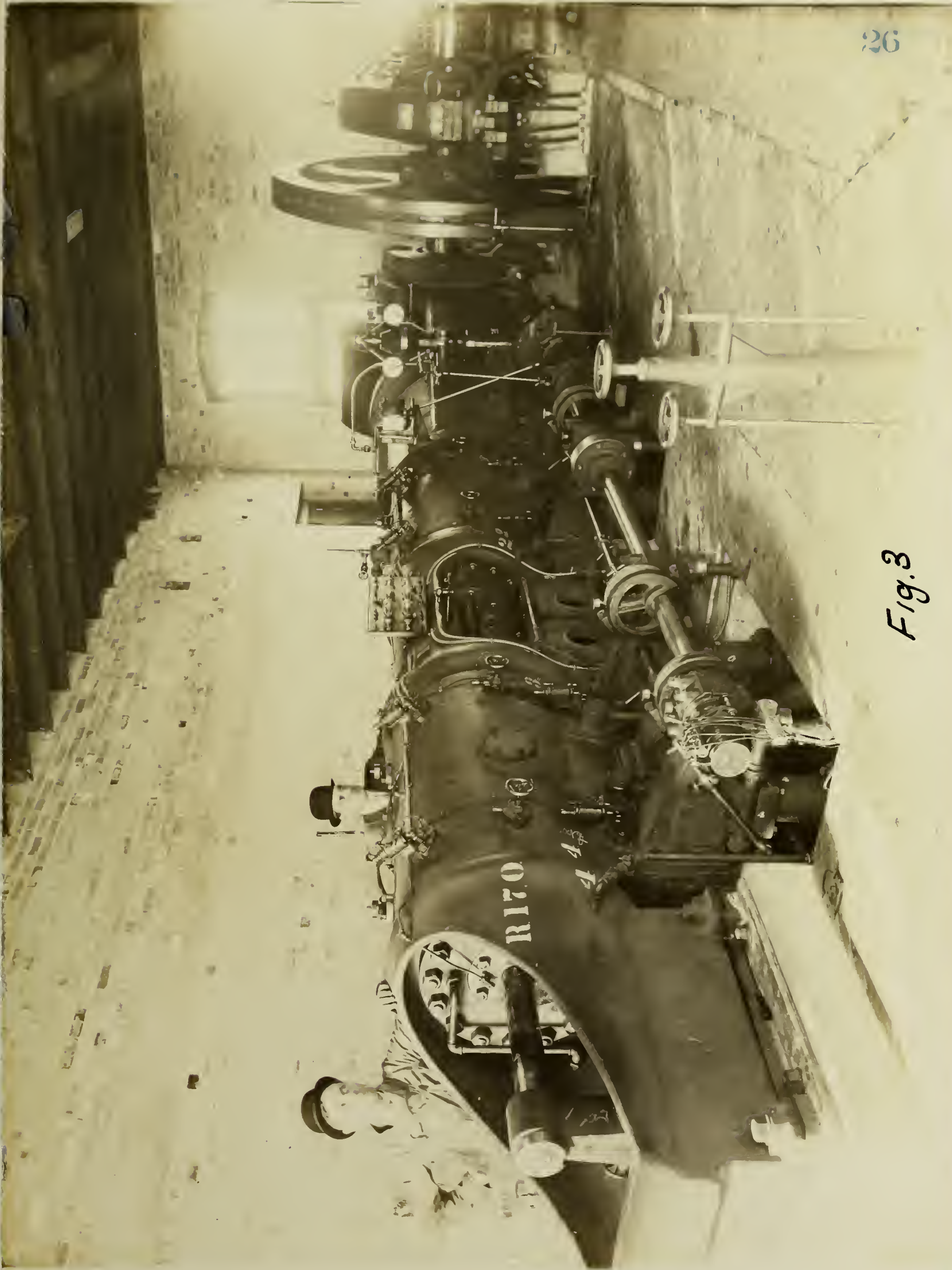
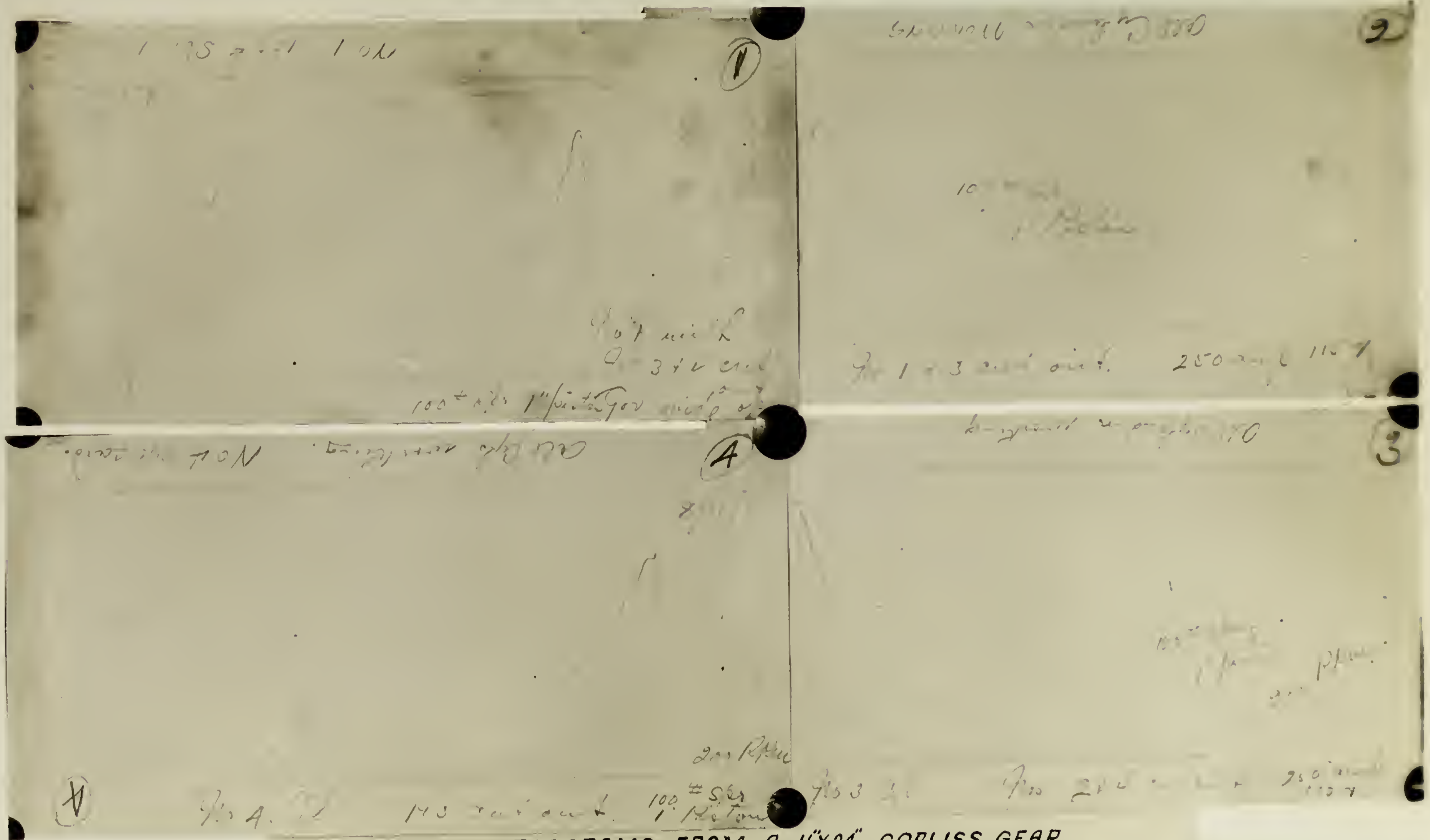


Fig. 3

Diesel oil engines, uniflow reciprocating steam engines the indicator diagrams of which vary but little from the diagrams of a two cycle gas engine, and gas engines approach so near each other in commercial efficiency, that to decide which prime mover is best adapted for the conditions under which it is to be installed, requires the judgment and consideration of one whose specialty is the generation of power.



INDICATOR DIAGRAMS FROM A 16"X24" CORLISS GEAR SARGENT COMPLETE EXPANSION GAS ENGINE WITH PRODUCER GAS

Fig. 4

C. E. SARGENT.

GAS ENGINE.

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1,072,366.

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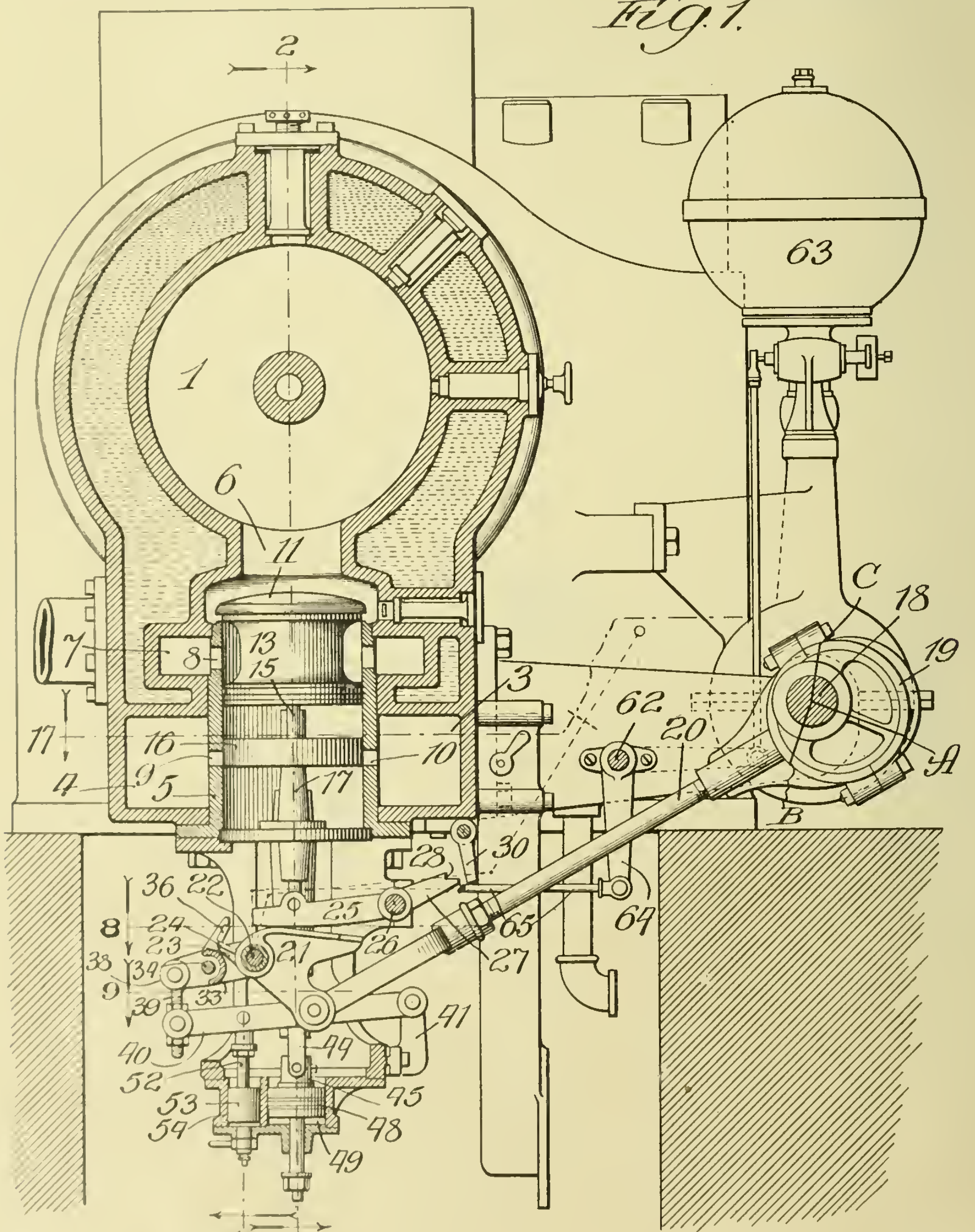
9 SHEETS—SHEET 1.

Fig. 1.



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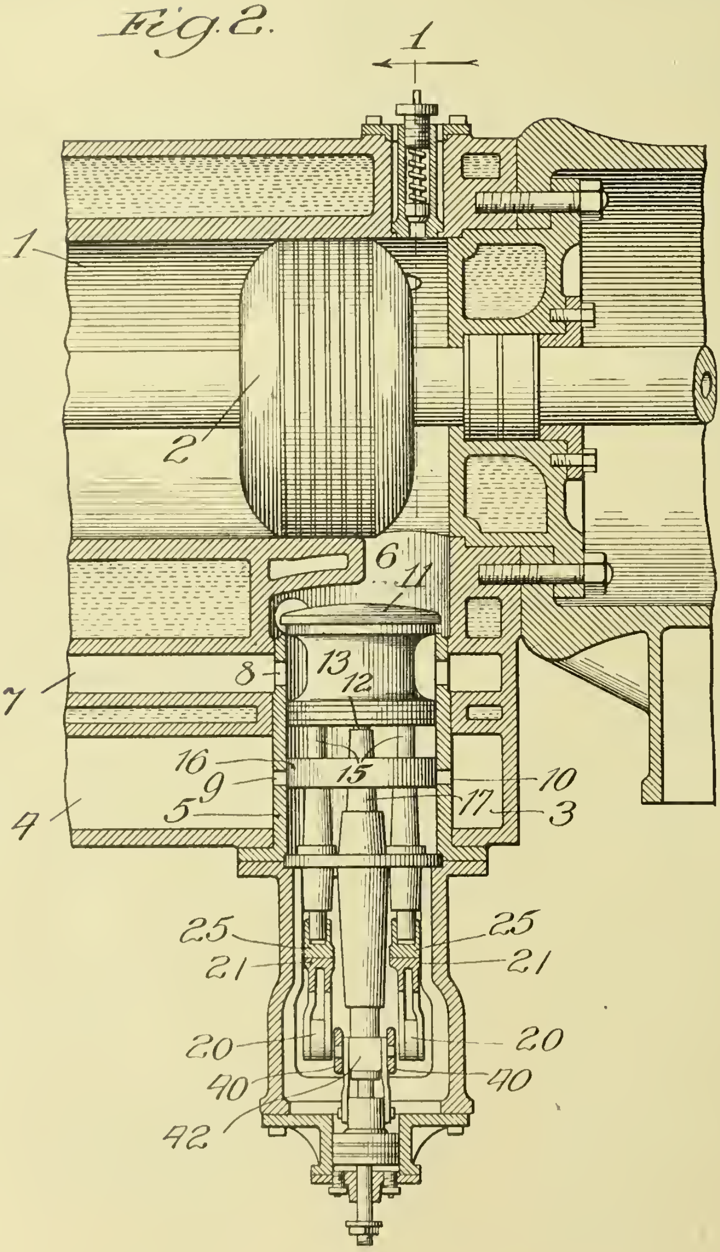
9 SHEETS—SHEET 2.

Fig. 2.



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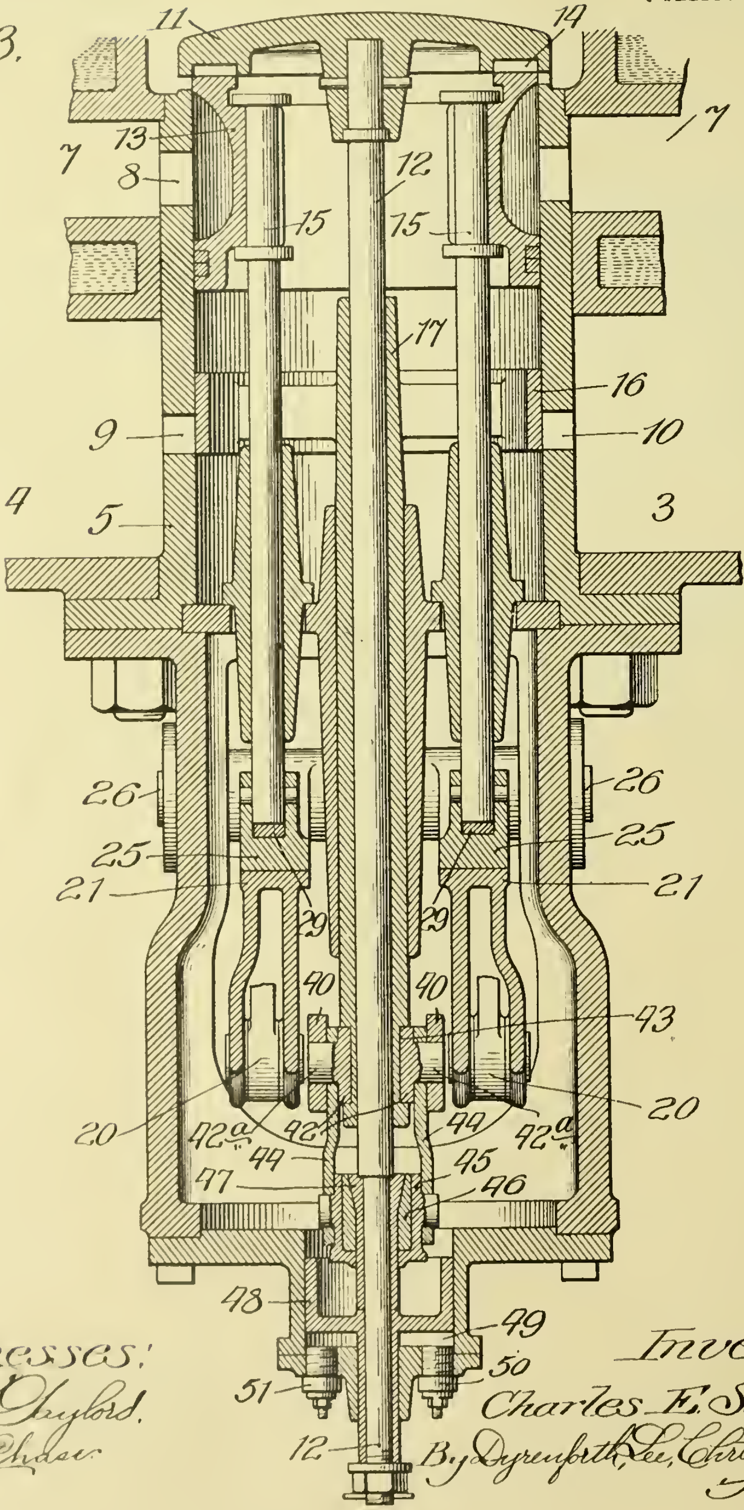
9 SHEETS—SHEET 3.

Fig. 3.



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9 SHEETS—SHEET 4.

Fig. 4.

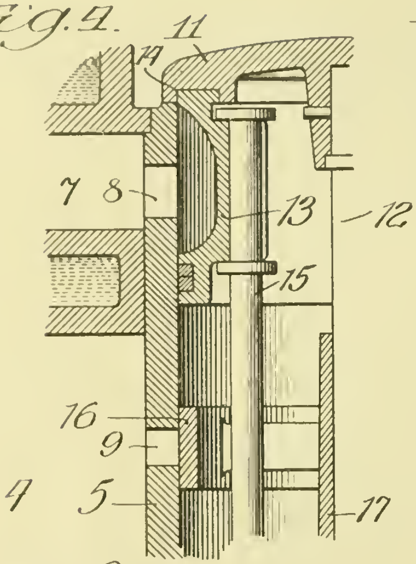


Fig. 5.

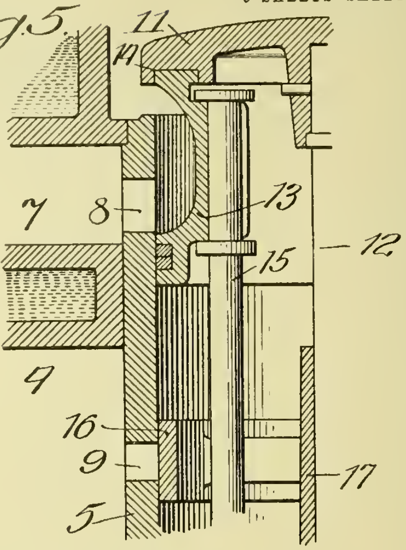


Fig. 6.

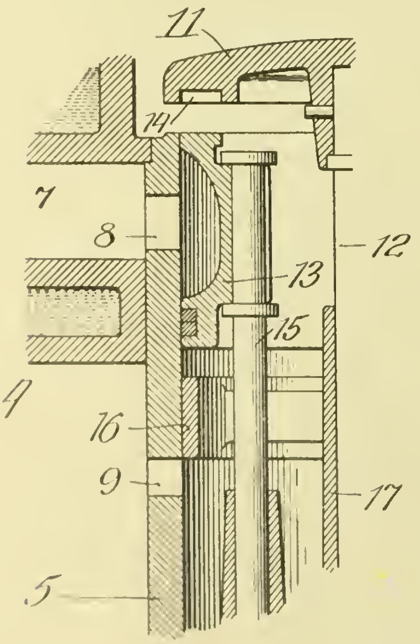
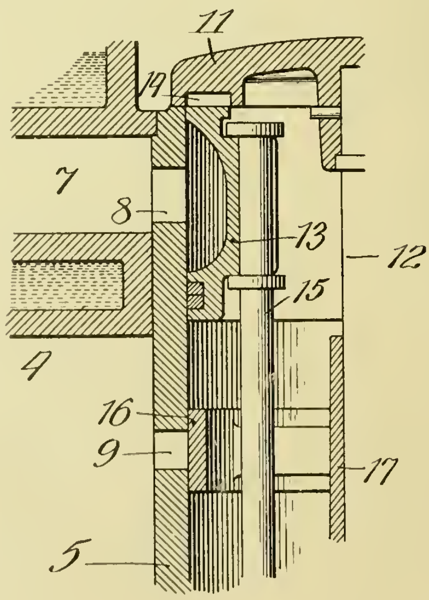


Fig. 7.



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9 SHEETS—SHEET 5.

Fig. 8.

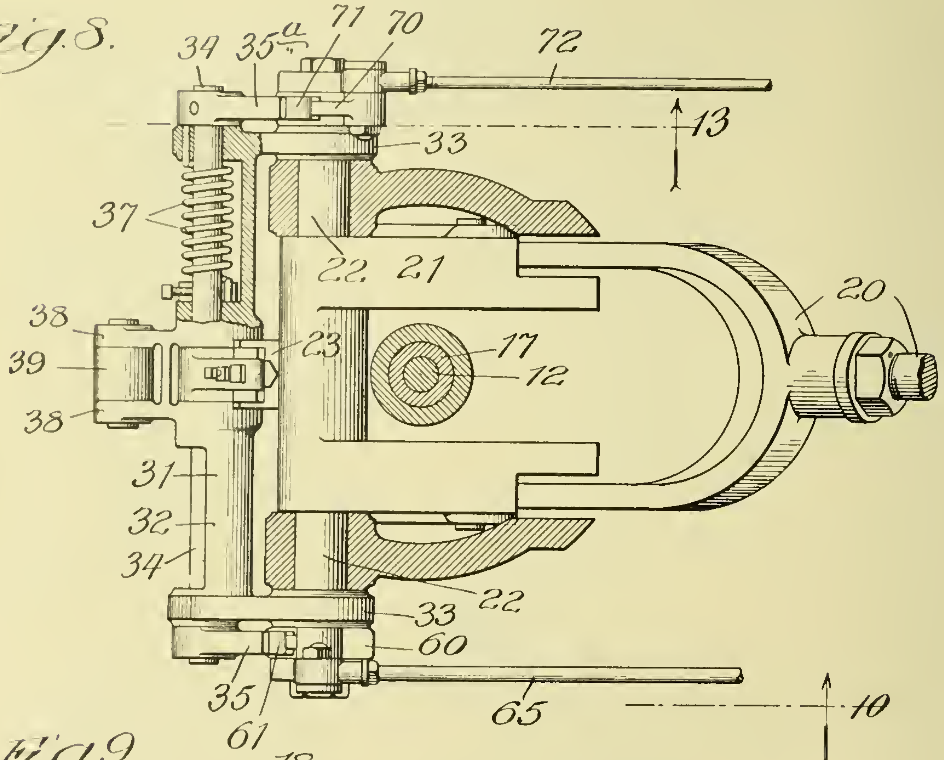
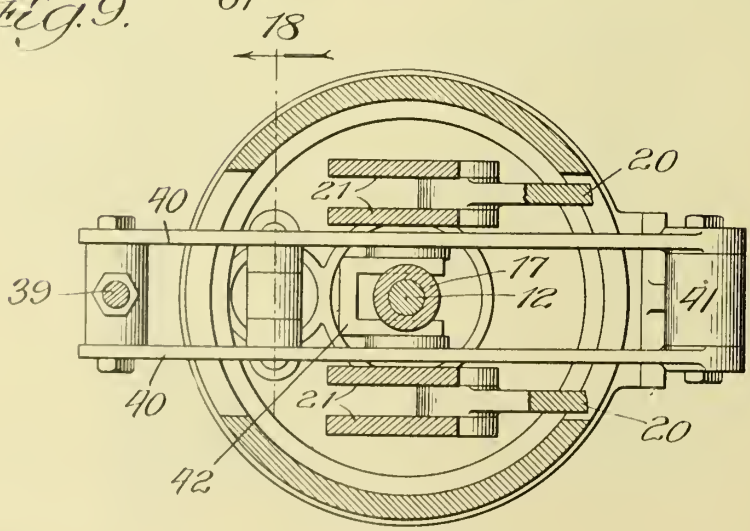


Fig. 9.



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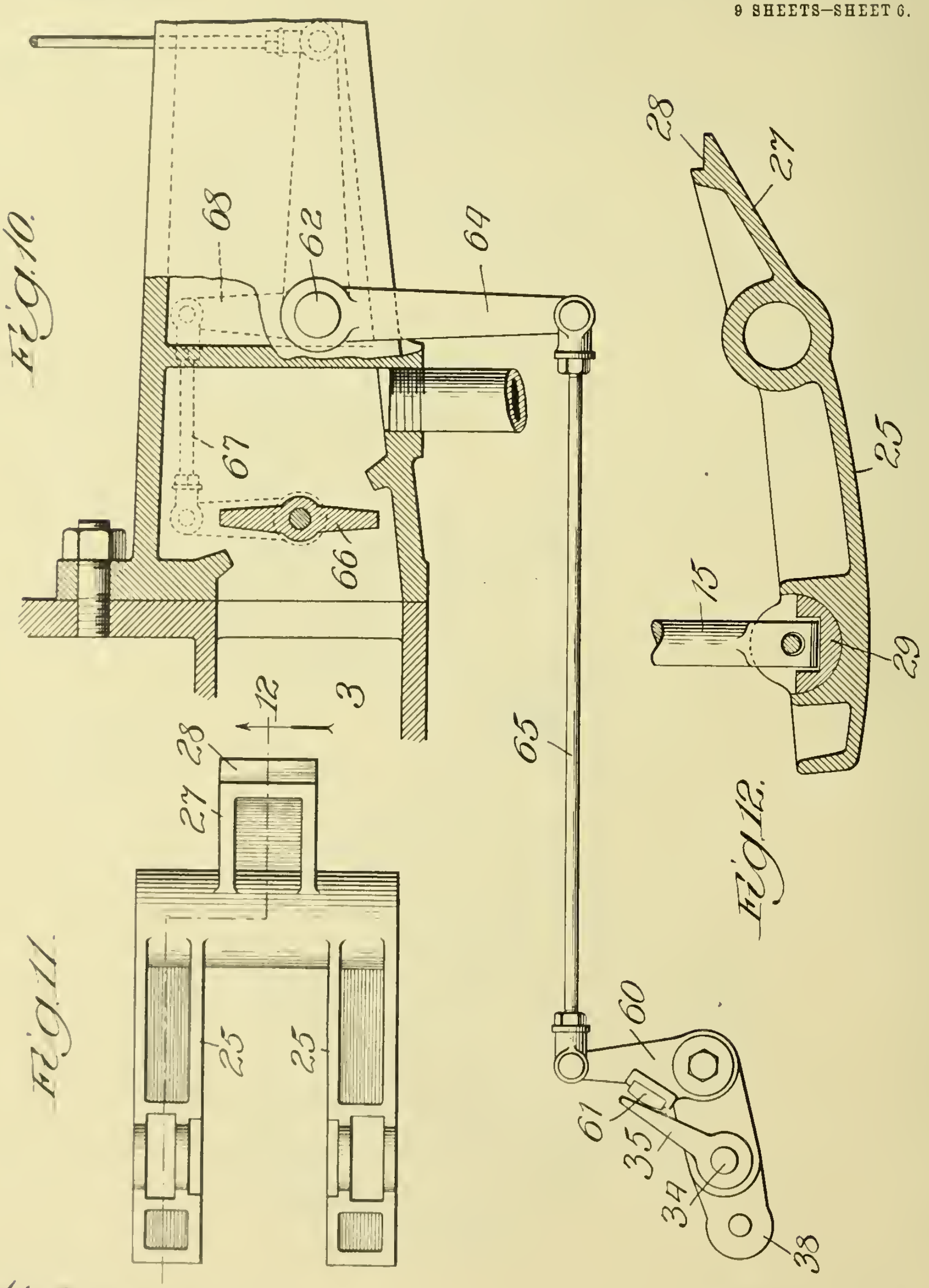
9 SHEETS—SHEET 6.



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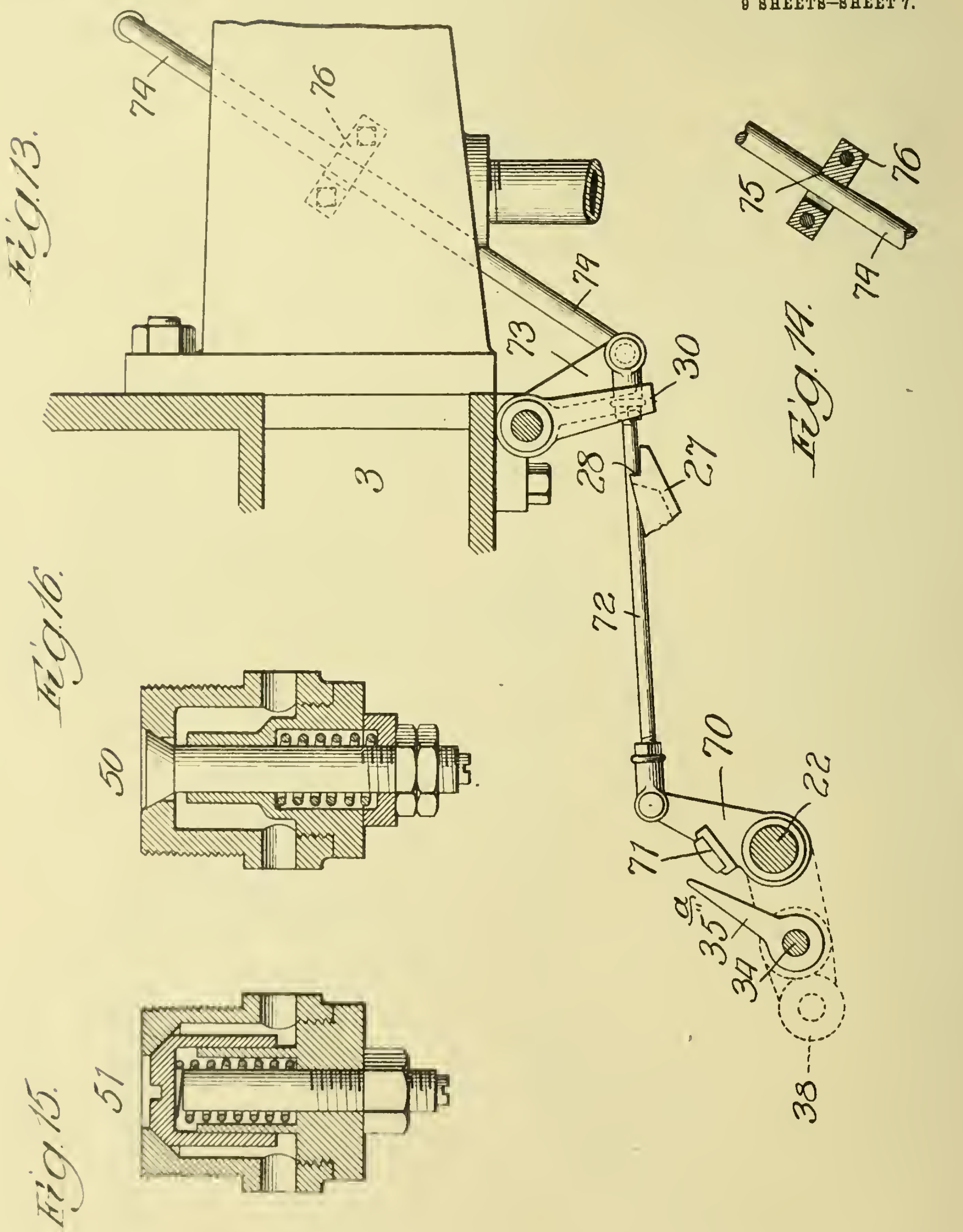
9 SHEETS—SHEET 7.



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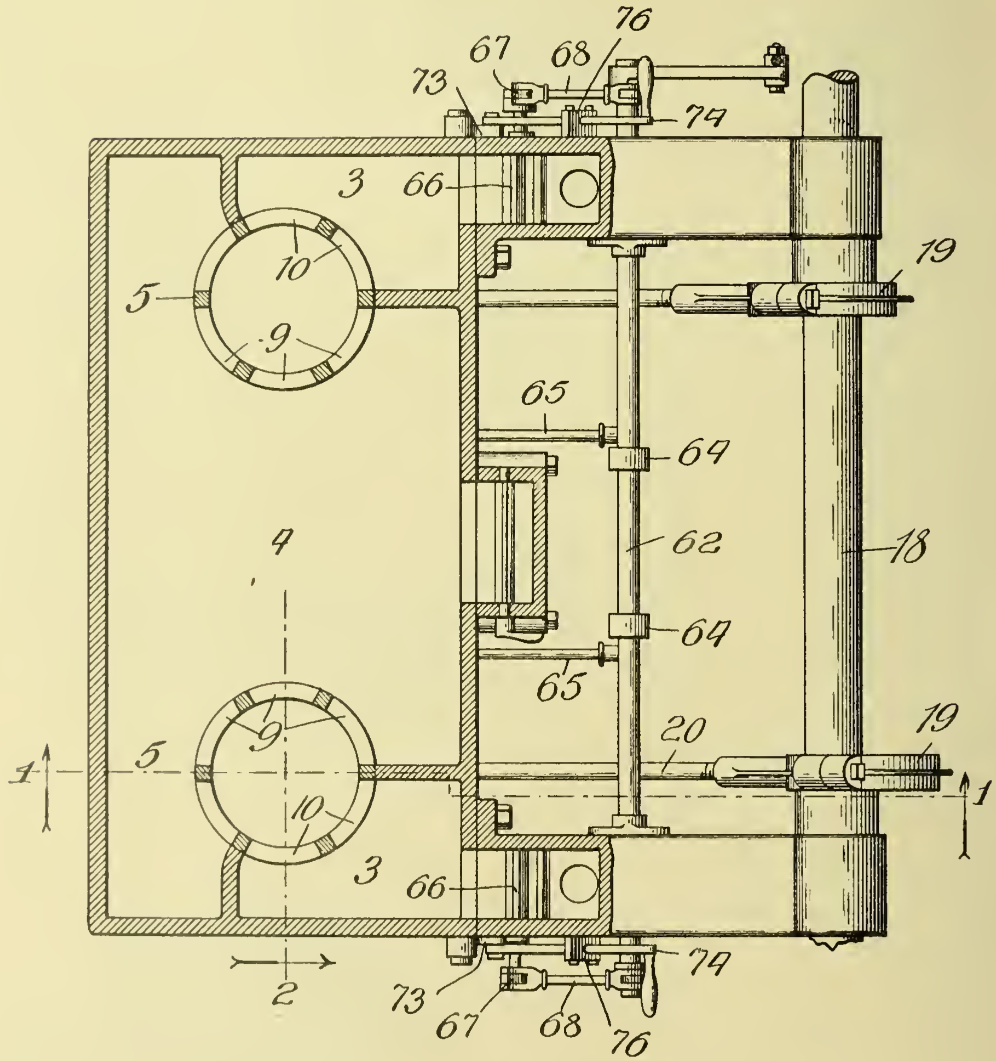
9 SHEETS—SHEET 8.

Fig. 17.



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1,072,366.

Patented Sept. 2, 1913.

9 SHEETS—SHEET 9.

Fig. 18.

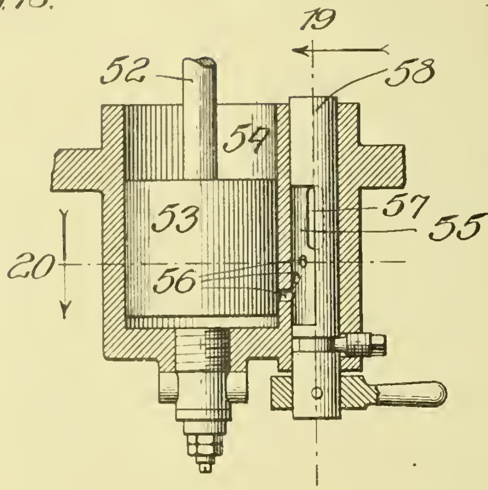


Fig. 19.

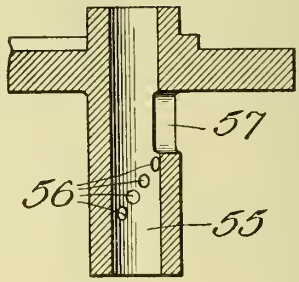


Fig. 20.

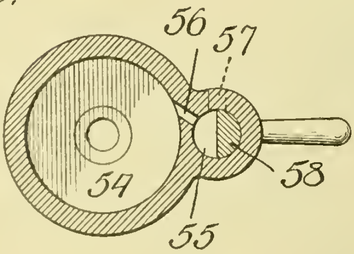


Fig. 22.

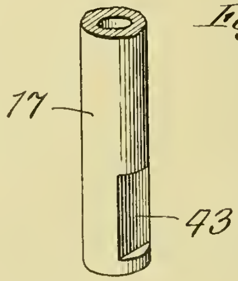


Fig. 21.

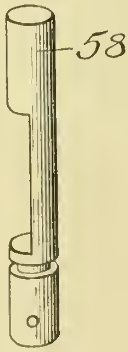
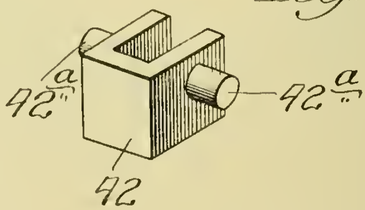


Fig. 23.



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UNITED STATES PATENT OFFICE.

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GAS-ENGINE.

1,072,366. Specification of Letters Patent. Patented Sept. 2, 1913.

Application filed February 8, 1911. Serial No. 607,258.

To all whom it may concern:

Be it known that I, CHARLES E. SARGENT, a citizen of the United States, residing at Chicago, in the county of Cook and State of Illinois, have invented a new and useful Improvement in Gas-Engines, of which the following is a specification.

My invention relates to certain new and useful improvements in a gas engine, and is fully described and explained in the specification and shown in the accompanying drawings, in which:

Figure 1 is a transverse section through my improved engine in the line 1 of Figs. 2 and 17; Fig. 2 is a central longitudinal section in the line 2 of Fig. 1; Fig. 3 is a longitudinal detailed section on the line 3 of Fig. 1; Figs. 4, 5, 6 and 7, are radial sections through the valves in four different positions, each view showing only half of the valve. Fig. 8 is a horizontal section on the line 8 of Fig. 1; Fig. 9 is a horizontal section on the line 9 of Fig. 1; Fig. 10 is a sectional view showing certain parts in a plane indicated by the line 10 of Fig. 8; Fig. 11 is a top plan of the rocker; Fig. 12 is a section on the line 12 of Fig. 11 through the rocker; Fig. 13 is a section on the line 13 of Fig. 8 showing, however, certain additional parts not illustrated in Fig. 8; Fig. 14 is a detailed section showing the cut-out rod arrangement; Fig. 15 is a section through the outlet-check valve of the dash-pot; Fig. 16 is a similar section through the inlet-check valve of the dash-pot; Fig. 17 is a horizontal section on the line 17 of Fig. 1; Fig. 18 is a vertical section on the line 18 of Fig. 1; Fig. 19 is a vertical section on the line 19 of Fig. 18; Fig. 20 is a horizontal section on the line 20 of Fig. 18; Fig. 21 is a perspective view of the adjusting pin shown in Figs. 18 and 20; Fig. 22 is a perspective view of the lower end of the valve-sleeve and Fig. 23 is a perspective view of the clip which coöperates therewith.

Referring to the drawings, 1 is a cylinder which is shown as one cylinder of a double-acting tandem engine, being divided by its piston 2 into explosion spaces. The present invention is independent of the particular arrangement or number of cylinders and for this reason it has not been deemed necessary to illustrate the complete engine nor more than one end of one of the cylinders in detail. It will be understood, of course, that in a double-acting tandem gas-engine there are four explosion spaces, two for each cylinder, and that the valve-mechanism at the opposite ends of each cylinder are symmetrically arranged. The drawings illustrate the head-end of that cylinder which is nearest to the crank in the tandem engine. The cylinder is mounted upon a hollow base which has at its two ends and on the one side, gas-chambers 3, and in its center an air-chamber 4. The partition walls of the hollow base are cut away, as is the bottom thereof, to receive at each end a cylindrical valve-cage 5, the cylinder being provided at its bottom with a port 6 in line therewith. The base is provided with an exhaust opening 7 separated from the remainder of the base by suitable partitions, said opening communicating, through a series of radial exhaust ports 8 in the valve-cage with the interior thereof. The air-chamber communicates with the interior of the valve-cage at a lower point through air-ports 9 and the gas-chamber in the base communicates therewith through gas-ports 10 on the same plane as the openings 9.

11 is a puppet-valve which seats on the top of the valve-cage. It is secured to a stem 12 which extends downward entirely through the valve-cage and out of the base of the engine, being connected with other parts which will be hereafter described.

13 is an annular exhaust valve which tightly fits the interior of the valve-cage and is provided with a peripheral groove adapted to register with the exhaust opening 8 to open communication therewith as will presently be set forth. The lower face of the puppet-valve 11 is provided with an annular groove 14 immediately above the edge of the annular-exhaust valve 13 into which groove the upper edge of said exhaust valve is adapted to fit. The exhaust valve is attached to exhaust-valve rods 15 which extend downward from the valve-cage and are adapted to be operated by other parts, presently to be described, for producing proper vertical movements of the exhaust valve.

16 is an intake valve closing the air and gas-ports and being in the form of a ring secured to a valve-sleeve 17 concentric with the puppet-valve stem 12.

Having thus described the form of the valves, their ports and the stems by which they are immediately operated, it is believed that the description of the devices which perform the movements of these parts can best be understood if the required movements be first set out. Figs. 4, 5, 6 and 7 illustrate the cycle of operation of these parts. Fig. 7 shows the position which the parts occupy during the working stroke. The puppet-valve is seated, the exhaust valve closes the exhaust port completely and the intake valve covers the air and gas-ports. 20 before the end of the working stroke the exhaust valve has moved up enough to reach the position shown in Fig. 4. The continued upward movement of the exhaust valve obviously raises the puppet, the parts taking the position shown in Fig. 5, which is occupied during the exhaust stroke. Toward the end of the exhaust stroke the exhaust valve begins to fall but in the meantime other devices operate on the puppet-valve stem and tend to hold the puppet up and simultaneously the sleeve to which the intake valve is attached is elevated so that the air and gas-ports are opened. (Fig. 6) the air and gas passing up through the interior of the valve-cage, through the center of the exhaust valve and into the cylinder in an obvious manner. This is the position which the parts occupy during the intake stroke, but when the cut-off point arrives the puppet and the sleeve are relieved from their elevating mechanism, suddenly drawn down, the parts then assuming their normal positions, shown in Fig. 7, which they maintain during the remainder of the intake stroke, the compression stroke and most of the working stroke until the exhaust valve is again opened.

18 is a counter-shaft, driven in the usual manner at half the speed of the crank-shaft. It carries an eccentric 19 which, through the medium of an eccentric rod 20, oscillates a cam 21 pivoted upon a shaft 22 extending longitudinally of the engine beneath the valve-cage and to one side of the center thereof. The form of the cam 21 will be best understood by reference to Figs. 1, 8 and 9, in which it is shown respectively, in side elevation, top plan and in horizontal section below its pivot. It will be observed from these drawings that it is bifurcated so as to straddle the valve-stem and sleeve. It has also, on the opposite side of its pivot from the counter shaft, a projection 23, the upper face of which carries a steel plate 24.

Immediately above the cam 21 and resting thereon is a rocker 25 pivoted upon a shaft 26, parallel to the shaft 22, and on the opposite side of a valve-stem therefrom. This rocker 25 is also bifurcated to straddle the valve-stem and sleeve, and its configuration is best shown in Figs. 11 and 12, which illustrate it in top plan and in section. It has, projecting on the opposite side of its shaft from the pivot of the cam 21 a teat 27 having a notch 28 adapted to be engaged by mechanism hereafter to be described for cutting out a cylinder by holding an exhaust valve open. The exhaust valve-stems 15 pass down through suitable guides and are provided at their lower ends with shoes 29, which afford therefor pivotal bearings in sockets provided for the purpose near the free end of the rocker 25. The construction thereof is obviously such that the rotation of the counter shaft will produce periodical elevations of the exhaust valve. In Fig. 1, the exhaust valve has just reached a line and line position in its closing movement, the counter shaft turning in a clockwise direction. Further movements in the same direction lowers the toe of the cam 21 and permits the exhaust valve to reach its lowest position (Fig. 7). During that part of a revolution when the eccentric rod is still farther to the right than in Fig. 1, the toe of the cam 21 would be further elevated and the exhaust valve will evidently be open (Fig. 5). This completes the description of the exhaust valve operation except for the mechanism for holding it permanently open to cut out a cylinder. This is accomplished through the medium of a finger 30, which can be swung to the left to engage the teat of the rocker to hold it permanently elevated. The finger 30 is operated by hand in conjunction with mechanism for preventing the opening of the intake valve, and the finger-operating mechanism will presently be described in connection with the intake-valve mechanism.

Journaled upon the shaft 22 is a yoke 31 (Figs. 1 and 8). This yoke is provided with a barrel 32 and two ears 33 which surround the shaft 22. Journaled in the barrel of the yoke is a cut-off shaft 34 which has at its two ends upwardly-projecting fingers 35 and 35^a, and has secured to its center a hook 36 which is adapted to engage the steel-plate 24 and carried by the projection of the cam 21. A spring 37 surrounds the cut-off shaft and tends to rotate it clockwise. The yoke has projecting backward, (that is away from the valve-stem) a pair of ears 38 supporting a link 39 which extends downward and is pivotally attached to the free end of a lever of the second order. This lever consists of two side-bars 40 pivoted at their ends to a bracket 41 and supporting pivotally between their ends a clip 42 (Figs. 9 and 23). The clip 42 has two studs 42^a which enter perforations in the side-bars 40 of the lever, and its center slips over and fits upon a flat portion 43 of the valve-sleeve 17 attached to the intake valve. The studs 42^a also serve as pivotal supports for downwardly extending links 44 which carry a cup 45 through which passes the valve-stem 12. The cup 45 carries a fiber or rawhide bushing 46 which engages with a conical collar 47 fast on the valve-stem 12 near its lower end. Below the collar 17, the valve-stem 12 is connected with a piston 18 which runs in a dash-pot 19 provided with intake plate and exhaust valves 50 and 51 respectively, whose construction is shown in detail in Figs. 15 and 16. These valves are set so that the valve-stem and puppet necessarily rise against a considerable suction but nevertheless enough air is let into the dash-pot by the valve 50 to cushion the fall of the puppet slightly, the opening of the dash-pot exhaust valve 51 being adjusted as to cause the necessary cushioning to occur. The lever comprised of the two side-bars 40 is connected by a link 52 to a gag-pot plunger 53 running in a gag-pot 54 at the bottom of which is an adjustable exhaust valve like that illustrated in Fig. 15. This dash-pot has, adjacent to one side, a cylindrical chamber 55 having a series of spirally arranged perforations 56 opening into the gag-pot and a longer perforation 57 open to the atmosphere. An adjusting rod 58 cut away on one side is rotatably secured in the vertical chamber adjacent to the gag-pot and by its rotation the perforations 56 can be successively closed beginning at the bottom. This construction is such that the gag-pot plunger will fall freely to the level of the lowest perforation 56 which is uncovered and afterward its descent will be cushioned. By turning the rod 58, the point at which the cushioning begins can be varied.

The construction has now been sufficiently described that the general mode of operation can readily be understood although certain parts still remain to be described. In Fig. 1 the parts are just at the end of the exhaust stroke and the commencement of the intake stroke. The exhaust valve has been open and is moving down, the puppet-valve is falling and the intake valve has just begun to rise. For purposes of convenience in description, I have designated three angular positions of the eccentric represented by the letters A, B and C. The position A is that which the eccentric occupies in Fig. 1. As the parts advance on the suction stroke, the eccentric traveling clockwise from the position A, and permits the cam 21 to descend so that the top of the exhaust valve becomes flush with the top of the valve-cage as shown in Fig. 6. In the meantime the hook 36 on the yoke 32 has engaged with the steel plate 24 on the projection 23 of the cam 21 so that the clockwise movement of the cam as its toe descends raises the yoke 31 thus drawing up the lever which consists of the two side-bars 40 and raising the intake valve to admit air and gas. The rise of the two side-bars 40 of the lever draws up the cup 45 through the medium of the links 44 until the raw-hide gasket or bushing in said cup engages the collar 47 at the lower end of the valve stem 12 so as to raise the same. The movements are so timed that the puppet-valve does not seat from the time the exhaust valve raises it because just as the exhaust valve commences to descend, the cup 41 commences to rise thus catching the puppet-valve in its descent and again elevating it.

While the eccentric is advancing from the point A to the point B (which is the latest point at which the cut off can occur), the intake is open, unless sooner effected by the governor operation hereafter to be described. Under all conditions the hook 36 will be disengaged from the steel plate carried by the cam 21 at points depending on the governor position and whenever the disengagement is effected the yoke, the side-bars 40 forming the lever, the intake valve and the puppet will all fall together making a sudden cut-off, the final movement of said parts being cushioned in the manner already set forth. From the time the eccentric reaches the point B, the intake, puppet and exhaust valves will remain in their normal positions until the eccentric reaches the point C, at which time the toe of the cam 21 will begin to rise to such an extent as to elevate the exhaust valve and puppet. The exhaust valve will be open until the point A is reached, which is that point illustrated in Fig. 1. As already set forth the exhaust opens 20° before the end of the working stroke and it closes exactly at the end of the exhaust stroke. It is therefore open 200° of the crank-shaft or 100° of the counter-shaft, and the arc A—C is thus 100°. The intake valve may be open the entire intake stroke or 180 degrees of the crank-shaft and 90° of the counter-shaft and the arc A—B is therefore 90°. The arc B—C represents 340° of the crank-shaft, that is, full turns less 20°, and it is therefore of 170°. It will, of course, be understood that the operation of the governor, as it disengages the hook on the yoke from the projection on the cam, will vary the point between A and B at which the cut off actually occurs, the point B being that point at which the intake stroke ceases and at or before which the cut off must occur and the valve be closed.

Turning now to the method of governing, 60 is an arm pivoted to the shaft 22 at one end thereof and carrying a fiber block 61 (Fig. 10) which is adapted to engage the finger 35 on the end of the cut-off-shaft 34 carried by the yoke 32. It will be evident that as the yoke swings up (carried by the engagement of the hook 36 with the steel-plate on the cam) the finger 35 will engage the fiber block 61 at varying points depending upon the position of the arm 60. The farther the arm is to the left as shown in Fig. 10 the earlier the engagement. When the finger engages the block it will obviously rotate the shaft 34 backward relative to the yoke and disengage the hook 36 from the cam, permitting the cut-off to occur. The arm 60 is connected to the governor and, by arranging the lever connection to the governor the arm 60 can be made to shift in either direction as the engine speeds up, thus making the cut off either earlier or later. One common method of governing engines is simply to make the cut off later as the load increases and to make the cut off earlier as the load decreases. Were it desired to use the present construction in connection with that method of governing, the governor would be arranged to shift the arm 60 to the left in Fig. 10 as the engine increased in speed. I prefer, however, to use another system of governing which I have devised. The constant mixture cycle of governing which has just been mentioned is that most commonly used. It has the disadvantage that as the load gets very light the charge becomes attenuated so that the compression becomes greatly reduced, the efficiency decreases and the cushion necessary to overcome the inertia of the reciprocating parts in the engines of a high piston speed is destroyed. Another well-known system is the constant compression method in which the air-supply is maintained constant, and the fuel content is decreased as the load gets lighter. This method provides a constant cushion for all loads, but with it the mixture frequently becomes so attenuated that it fails to explode and not only allows unburnt gases to pass into the exhaust but creates irregular impulses and a poor turning moment. My present system of governing accomplishes the desirable results of both these systems without the disadvantages of either.

62 indicates a rock-shaft operated by a governor 63 through a lever system of the ordinary sort connected in such a way that the shaft 62 turns counter clockwise as the engine speeds up. The rock-shaft 62 is provided with a radial arm 64 connected by a link 65 with the arm 60 so that as the engine speeds up the arm 60 is moved to the right, thus making the cut-off later. The gas intake to the gas space 3 in the base of the engine is controlled by a butterfly valve 66, connected by a link 67 with a second radial arm 68 on the rock-shaft 62. This connection is such that, as the shaft 62 rotates counter clockwise, the butterfly valve will be gradually closed. The parts are so adjusted that at the maximum load and about $\frac{3}{4}$ cut off the compression is as high as is commercial without prematuring, when the mixture gives the best combustion and the highest mean effective pressure. Under these conditions there is a certain density of the gas and air molecules which can not be exceeded on account of the dangers of a premature explosion caused by the heat of higher compression. It is well known that the weaker the mixture, the higher the compression may be without premature explosions and it is this fact of which I take advantage in my system of governing. As the engine speeds up, gas and air are admitted until a later point, so that the compression is increased, but simultaneously the gas content is decreased to such an extent as to prevent a premature explosion and yet not so fast as to prevent proper ignition. As a result, high efficiency and low mean effective pressure is obtained. If, for instance, a mixture giving the highest mean effective pressure at $\frac{3}{4}$ cut off is used and the butterfly valve is so arranged that at 100 per cent. cut off just enough gas will be admitted to run the engine at full speed without a load the consumption curve per brake horsepower will be much flatter than in engines using any of the ordinary types of governing. Assuming, for instance, a $\frac{3}{4}$ cut off with a clearance which would, at that cut off, give a compression of 134 pounds absolute pressure, then with $\frac{7}{8}$ cut off we will get a compression of 190 pounds absolute; and with 100 per cent. cut off a compression of 234 pounds. Now, assuming that it is desired to maintain the same density of the gas-content at the time of explosions, and this is an important factor in determining whether or not there will be pre-ignition, we find the requirements to be as follows:—If, at $\frac{3}{4}$ cut off $13\frac{1}{2}$ pounds absolute compression and 240° Fahrenheit temperature, a cubic foot of mixture contains 43 British thermal units, then at $\frac{7}{8}$ cut off, other conditions being the same, only 37 British thermal units per cubic foot would be required to get the same density of fuel content when compressed, and at 100 per cent. cut off only 32 British thermal units would be required to get the same density of compression. The fuel content could therefore be decreased in accordance with these ratios without getting pre-ignition. It could even be decreased faster because under greater compression a still weaker mixture will burn on account of the extra heat of the higher compression. The gas may thus be diminished in a more rapid ratio than the compression rises and still get a burnable mixture at all loads and speeds. It will be obvious that this system of governing with its higher compression and its perfectly regular explosions is superior to either of these heretofore mentioned.

When it is desired to cut out a single cylinder for the purpose of changing spark-plugs or for other purposes, the mechanism illustrated more particularly in Fig. 13 is made use of. On the opposite end of the shaft 22 from the arm 60 is pivoted another arm 70 carrying a fiber block 71 in position to be engaged by the finger 35^a, which, like the finger 35 is attached to the cut off shaft

34. The arm 70 is connected to a link 72 attached to the end of an arm 73 which is operable by a hand-lever 74 provided with a notch 75 adapted to engage a bracket 76. In its normal position the arm 70 is held back, the notch 75 engaging with a bracket 76. When it is desired to cut out a cylinder the arm is permitted to move to the left, as viewed in Fig. 13, with the result that the finger 35[a] engaged therewith so early as not to open the intake valve at all. The link 72 engages the cut out finger 30 so that when the link moves to the left, it lets the cut out finger engage with the teat 27 of the rocker 25 thus holding the exhaust valve permanently open so that no compression takes place in the cylinder. It is obvious that retraction of the hand-lever 74 will restore other parts to their operative position.

I realize that considerable variation is possible in the details of the construction, without departing from the spirit of my invention; therefore I do not intend to limit myself to the specific form herein shown and described.

What I claim as new and desire to secure by Letters Patent, is—

1. In a gas-engine, a cylinder, a piston movable therein, an intake-valve, a rocking member, means for oscillating said rocking member regularly once for each two reciprocations of the piston, intake-valve operating means, releasable connections between the intake-valve operating means and the rocking member whereby the oscillations of the rocking member will operate the intake-valve, means for releasing said connections, and means for returning the intake-valve to closed position upon release of the connections, an exhaust-valve, connections between the same and the rocking member whereby the oscillations of the rocking member will operate the exhaust-valve.

2. In a gas-engine, a cylinder, a piston movable therein, an intake-valve, a rocking member, means for oscillating said rocking member regularly once for each two reciprocations of the piston, intake-valve operating means, releasable connections between the intake-valve operating means and the rocking member whereby the oscillations of the rocking member will operate the intake-valve, means for disengaging said connections, a dash-pot and a piston therein and connections between the piston and the intake-valve for closing the same upon release of the connections, an exhaust-valve and connections between the same and the rocking member whereby the oscillations of the rocking member will operate the exhaust-valve.

3. In a gas-engine a cylinder, a piston movable therein, an intake and an exhaust-valve, a rocking member, means for oscillating said rocking member regularly once for each two reciprocations of the piston, intake-valve operating means, releasable connections between the intake-valve operating means and the rocking member whereby the oscillations of the rocking member will operate the intake valve, means for disengaging said connections, means for returning the intake-valve to closed position upon release of the connections, and a puppet-valve covering both the intake and exhaust-valves and adapted to be open while each of said valves is open.

4. In a gas-engine a cylinder, a piston movable therein, an intake and an exhaust-valve, a rocking member, means for oscillating said rocking member once for each two reciprocations of the piston, intake-valve operating means, releasable connections between the intake-valve operating means and the rocking member whereby the oscillations of the rocking member will operate the intake-valve, means for disengaging said connections, a dash-pot and a piston therein, connections between the piston and the intake-valve for closing the same upon release of the connections, and a puppet-valve covering both the intake and exhaust-valves and adapted to be open while each of said valves is open.

5. In a gas-engine a cylinder, a piston movable therein, an intake-valve, a rocking member, means for oscillating said rocking member regularly once for each two reciprocations of the piston, intake-valve operating means, releasable connections between the intake-valve operating means and the rocking member whereby the oscillations of the rocking member will operate the intake-valve, means for disengaging said connections, means for returning the intake-valve to closed position upon release of the connections, an exhaust-valve, connections between the same and the rocking member whereby the oscillations of the rocking member will operate the exhaust-valve, and a puppet-valve covering both the intake and exhaust-valves and adapted to be open while each of said valves is open.

6. In a gas-engine a cylinder, a piston movable therein, an intake-valve, a rocking member, means for oscillating said rocking member once for each two reciprocations of the piston, intake-valve operating means, releasable connections between the intake-valve operating means and the rocking member whereby the oscillations of the rocking member will operate the intake-valve, means for disengaging said connections, a dash-pot and a piston therein, connections between the piston and the intake-valve for closing the same upon release of the connections, an exhaust-valve and connections between the same and the rocking member whereby the oscillations of the rocking member will

operate the exhaust valve, and a puppet-valve covering both the intake and exhaust-valves and adapted to be open while each of said valves is open.

7. In a gas-engine a cylinder, a piston movable therein, an intake and an exhaust-valve, a rocking member, means for oscillating said rocking member regularly once for each two reciprocations of the piston, intake-valve operating means, releasable connections between the intake-valve operating means and the rocking member whereby the oscillations of the rocking member will operate the intake-valve, means for disengaging said connections, means for returning the intake-valve to closed position upon release of the connections, a puppet-valve covering both the intake and exhaust-valves and arranged to be engaged and opened by the exhaust-valve, means operated by the intake-valve operating means for holding the puppet open during the opening of the intake-valve and means for closing the puppet when the connections are released.

8. In a gas-engine, a cylinder, a piston movable therein, an intake and an exhaust-valve, a rocking member, means for oscillating said rocking member once for each two reciprocations of the piston, intake-valve operating means, releasable connections between the intake-valve operating means and the rocking member whereby the oscillation of the rocking member will operate the intake-valve, means for disengaging said connections, a dash-pot and piston therein, connections between the piston and the intake-valve for closing the same upon release of the connections, a puppet-valve covering both the intake and exhaust-valves and arranged to be engaged and opened by the exhaust-valve, means operated by the intake-valve operating means for holding the puppet open during the opening of the intake-valve, and means for closing the puppet when the connections are released.

9. In a gas-engine a cylinder, a piston movable therein, an intake-valve, a rocking member, means for oscillating said rocking member regularly once for each two reciprocations of the piston, an intake-valve, intake valve operating means, releasable connections between the intake-valve operating means and the rocking member whereby the oscillations of the rocking member will operate the intake valve, means for disengaging said connections, means for returning the intake valve to closed position upon release of the connections, an exhaust-valve, connections between the same and the rocking member whereby the oscillations of the rocking member will operate the exhaust-valve, a puppet-valve covering both the intake and the exhaust-valves and arranged to be engaged and opened by the exhaust-valve, means operated by the intake-valve operating means for holding the puppet open during the opening of the intake-valve and means for closing the puppet when the connections are released.

10. In a gas-engine a cylinder, a piston movable therein, an intake-valve, a rocking member, means for oscillating said rocking member once for each two reciprocations of the piston, intake-valve operating means, releasable connections between the intake-valve operating means and the rocking member whereby the oscillations of the rocking member will operate the intake valve, means for disengaging said connections, a dash-pot and a piston therein, connections between the piston and the intake-valve for closing the same upon release of the connections, an exhaust-valve and connections between the same and the rocking member whereby the oscillations of the rocking member will operate the exhaust-valve, a puppet-valve covering both the intake and the exhaust-valve and arranged to be engaged and opened by the exhaust-valve, means operated by the intake-valve operating means for holding the puppet open during the opening of the intake-valve and means for closing the puppet when the connections are released.

11. In combination a cylinder and a piston therein, a valve-cage opening into the cylinder, exhaust and intake-ports entering the valve-cage, annular exhaust and intake-valves normally covering said ports and independently movable to uncover the same and means for successively operating said valves.

12. In combination a cylinder and a piston therein, a valve-cage opening into the cylinder, exhaust and intake-ports entering the valve-cage, annular exhaust and intake-valves normally covering said ports and independently movable to uncover the same and means for successively operating said valves, and a puppet closing the valve-cage and adapted to be opened during the opening of each of said valves.

13. In combination a cylinder and a piston therein, a valve-cage opening into the cylinder, exhaust and intake-ports entering the valve-cage, annular exhaust and intake-valves normally covering said ports and independently movable to uncover the same and means for successively operating said valves, and a puppet closing the valve-cage and adapted to be lifted by the exhaust-valve in its movement.

14. In combination a cylinder and a piston therein, a valve-cage opening into the cylinder, exhaust and intake-ports entering the valve-cage, annular exhaust and intake-valves normally covering said ports and independently movable to uncover the same, means for successively operating said valves,

a puppet closing the valve-cage and adapted to be lifted by the exhaust valve in its movement, and mechanism for holding the puppet open while the intake-valve is open.

15. In combination a cylinder and a piston therein, a valve-cage opening into the cylinder, exhaust and intake-ports entering the valve cage, an annular exhaust-valve having a peripheral groove normally closing said exhaust-port and arranged when raised above the level of the valve-cage to open communication through said groove from said exhaust-port to the cylinder, an annular intake-valve normally covering the intake-port and movable independently of the exhaust-valve, and means for successively operating said valves.

16. In combination a cylinder and a piston therein, a valve-cage opening into the cylinder, exhaust and intake-ports entering the valve-cage, an annular exhaust-valve having a peripheral groove normally closing said exhaust-port and arranged when raised above the level of the valve-cage to open communication through said groove from said exhaust-port to the cylinder, an annular intake-valve normally covering the intake-port and movable independently of the exhaust-valve, and means for successively operating said valves, and a puppet closing the valve-cage and adapted to be opened during the opening of each of said valves.

17. In combination a cylinder and a piston therein, a valve-cage opening into the cylinder, exhaust and intake-ports entering the valve-cage, an annular exhaust-valve having a peripheral groove normally closing said exhaust-port and arranged when raised above the level of the valve-cage to open communication through said groove from said exhaust-port to the cylinder, an annular intake-valve normally covering the intake-port and movable independently of the exhaust-valve and means for successively operating said valves, and a puppet closing the valve-cage and adapted to be lifted by the exhaust-valve in its movement.

18. In combination a cylinder and a piston therein, a valve-cage opening into the cylinder, exhaust and intake-ports entering the valve-cage, an annular intake-valve normally covering the intake-port and movable independently of the exhaust-valve, means for successively operating said valves, a puppet closing the valve-cage and adapted to be lifted by the exhaust valve in its movement, and mechanism for holding the puppet open while the intake-valve is open.

19. In combination a cylinder and a piston movable therein, an exhaust-valve, an intake-valve, a toe-cam, means for rocking the toe-cam, operating mechanism between the toe-cam and the exhaust-valve, intake-valve operating means, a releasable connection between the intake-valve operating means and the toe-cam, means for releasing said connection and means for closing the intake-valve upon the release of said connection.

20. In combination a cylinder and a piston movable therein, an exhaust-valve, an intake-valve, a toe-cam, means for rocking the toe-cam, operating connections between the toe-cam and the exhaust-valve, intake-valve operating means, a releasable connection between the intake-valve operating means and the toe-cam, means for releasing said connection, means for closing the intake-valve upon the release of said connection and a puppet inclosing both of said valves and adapted to be open while each is open.

21. In combination a cylinder and a piston movable therein, an exhaust-valve, an intake-valve, a toe-cam, means for rocking the toe-cam, operating connections between the toe-cam and the exhaust-valve, intake-valve operating means, a releasable connection between the intake-valve operating means and the toe-cam, means for releasing said connection, means for closing the intake-valve upon the release of said connection, and a puppet-valve covering both the intake and exhaust-valves and arranged to be engaged and opened by the exhaust-valve, means operated by the intake-valve operating means for holding the puppet open during the opening of the intake-valve and means for closing the puppet when the connections are released.

22. In combination, a cylinder and a piston movable therein, an exhaust-valve, an intake-valve, a toe-cam, means for rocking the toe-cam, operating connections between the toe-cam and the exhaust-valve, a pivoted member, a hook carried thereby and adapted to engage the toe-cam, governor operated means for releasing the hook, connections between the pivoted member and the intake-valve and means for closing the intake-valve upon the release of the hook.

23. In combination a cylinder and a piston therein, a valve-cage opening into the cylinder, intake and exhaust-ports entering the valve-cage, annular exhaust and intake-valves normally covering said ports and independently movable to uncover the same, a toe-cam and means for rocking the same, connections between the toe-cam and the exhaust-valve, a pivoted member, connections between the same and the intake-valve, a hook carried by the pivoted member and adapted to engage the toe-cam, and means for closing the intake-valve when said hook is released, and governor operated means for effecting the release of said hook.

24. In combination a cylinder and a piston movable therein, a valve-cage opening into the cylinder, intake and exhaust-valve

ports entering the valve-cage, annular intake and exhaust valves independently movable in the valve cage, a toe-cam, means for rocking the toe-cam, means for connection between the toe-cam and the exhaust-valve, a pivoted member, connections between the pivoted member and the intake-valve, a hook carried by said pivoted member and adapted to engage the toe-cam, governor operated means for disengaging the hook from the toe-cam, a puppet-valve covering the valve-cage and adapted to be engaged by the exhaust-valve and opened thereby, means movable with the intake-valve for engaging the puppet to hold the same open, a dash-pot and a piston movable therein connected to said puppet whereby upon the release of said hook the puppet will be drawn down and will draw with it said intake-valve.

25. In combination a cylinder and a piston movable therein, a cylindrical valve-cage opening into the cylinder, exhaust and intake-ports in the valve-cage, annular exhaust and intake-valves independently movable in the valve-cage to cover and uncover said ports, a toe-cam and means for rocking the same, connections between the toe-cam and the exhaust-valve, a puppet-valve closing the valve-cage and arranged to be engaged and opened by the exhaust-valve, means for closing the puppet-valve when released, intake valve-operating means, a releasable connection between the toe-cam and the intake-valve operating means, means for releasing said connection to permit the intake-valve to be closed, and means of engagement between the intake-valve and the puppet-valve operating to limit the upward movement of the intake-valve relative to the puppet whereby upward movement of the intake-valve raises the puppet and the fall of the puppet closes the intake-valve but whereby also the puppet may rise without the intake-valve.

26. In combination a cylinder and a piston movable therein, a cylindrical valve-cage opening into the cylinder, exhaust and intake-ports in the valve-cage, annular exhaust and intake-valves independently movable in the valve-cage to cover and uncover said ports, a toe-cam and means for rocking the same, connections between the toe-cam and the exhaust-valve, a puppet-valve closing the valve-cage and arranged to be engaged and opened by the exhaust-valve, a dash-pot, a piston therein connected to the puppet to close the same, intake-valve operating means, a releasable connection between the toe-cam and the intake-valve operating means, means for releasing said connection to permit the intake valve to be closed, and means of engagement between the intake-valve and the puppet valve operating to limit the upward movement of the intake-valve relative to the puppet whereby upward movement of the intake-valve raises the puppet and the fall of the puppet closes the intake-valve but whereby also the puppet may rise without the intake-valve.

27. In combination a cylinder and a piston movable therein, a cylindrical valve-cage opening into the cylinder, exhaust and intake-ports in the valve-cage, annular exhaust and intake-valves independently movable in the valve-cage to cover and uncover said ports, a toe-cam and means for rocking the same, connections between the toe-cam and the exhaust-valve, a puppet-valve closing the valve-cage and arranged to be engaged and opened by the exhaust-valve, means for closing the puppet-valve when released, intake-valve operating means, a pivoted yoke connected to the intake-valve to raise the same, a hook carried by the yoke and adapted to engage the toe-cam, a governor, means movable by the governor for releasing the hook, and means of engagement between the intake-valve and the puppet-valve operating to limit the upward movement of the intake-valve raises the puppet and the fall of the puppet closes the intake-valve but whereby also the puppet may rise without the intake-valve.

28. In combination a cylinder and a piston movable therein, a cylindrical valve-cage opening into the cylinder, exhaust and intake-ports in the valve-cage, annular exhaust and intake-valves independently movable in the valve-cage to cover and uncover said ports, a toe-cam and means for rocking the same, connections between the toe-cam and the exhaust-valve, a puppet-valve closing the valve-cage and arranged to be engaged and opened by the exhaust-valve, means for closing the puppet-valve when released, intake-valve operating means, a releasable connection between the toe-cam and the intake-valve operating means, means for releasing said connection to permit the intake-valve to be closed, means of engagement between the intake-valve and the puppet-valve operating to limit the upward movement of the intake-valve relative to the puppet whereby upward movement of the intake-valve raises the puppet and the fall of the puppet closes the intake-valve but whereby also the puppet may rise without the intake-valve, and means for cushioning the fall of the intake-valve.

29. In combination a cylinder and a piston movable therein, a cylindrical valve-cage opening into the cylinder, exhaust and intake-ports in the valve-cage, annular exhaust and intake-valves independently movable in the valve-cage to cover and uncover said ports, a toe-cam and means for rocking the same, connections between the toe-cam and the exhaust-valve, a puppet-valve closing the valve-cage and arranged to be engaged and opened by the exhaust-valve, a

dash-pot, a piston therein connected to the puppet to close the same, intake-valve operating means, a releasable connection between the toe-cam and the intake-valve operating means, means for releasing said connection to permit the intake-valve to be closed, means of engagement between the intake-valve and the puppet-valve operating to limit the upward movement of the intake-valve relative to the puppet whereby upward movement of the intake-valve raises the puppet and the fall of the puppet closes the intake-valve but whereby also the puppet may rise without the intake-valve, and means for cushioning the fall of the intake-valve.

30. In combination a cylinder and a piston movable therein, a cylindrical valve-cage opening into the cylinder, exhaust and intake-ports in the valve-cage, annular exhaust and intake-valves independently movable in the valve-cage to cover and uncover said ports, a toe-cam and means for rocking the same, connections between the toe-cam and the exhaust-valve, a puppet-valve closing the valve-cage and arranged to be engaged and opened by the exhaust-valve, means for closing the puppet-valve when released, intake-valve operating means, a pivoted yoke connected to the intake-valve to raise the same, a hook carried by the yoke and adapted to engage the toe-cam, a governor, means movable by the governor for releasing the hook, means of engagement between the intake-valve and the puppet-valve operating to limit the upward movement of the intake-valve relative to the puppet whereby upward movement of the intake-valve raises the puppet and the fall of the puppet closes the intake-valve but whereby also the puppet may rise without the intake-valve, and means for cushioning the fall of the intake-valve.

31. In a gas-engine a cylinder and a piston movable therein, means for supplying a gaseous mixture to the cylinder, means for gradually increasing the quantity of mixture and for gradually decreasing the gaseous content of the mixture as the speed of the engine increases.

32. In a gas-engine a cylinder and a piston movable therein, an intake-valve, means for supplying a gaseous mixture to the intake-valve, means for varying the time of closing the intake-valve, and means for gradually delaying the time of closing the intake-valve and for gradually decreasing the gaseous content of the mixture as the speed of the engine increases.

33. In combination a cylinder having intake and exhaust-ports and a piston movable therein, a governor, a device for gradually varying the proportion of the mixture drawn into the engine, a device for gradually varying the quantity of mixture drawn into the engine, means connecting said devices with the governor to actuate the same thereby, so as to decrease the gaseous content of the mixture and increase the quantity of the mixture as the speed of the engine increases.

34. In combination a cylinder having intake and exhaust-ports and a piston movable therein, a governor, a device for gradually varying the proportions of the mixture drawn into the engine, a device for gradually varying the point of closing of the intake-valve, means connecting said devices with the governor to actuate the same thereby, so as to gradually decrease the gaseous content of the mixture and cause a later and later closing of the intake-valve as the speed of the engine increases.

CHARLES E. SARGENT.

In the presence of—
A. N. Thorien,
R. A. Raymond.

PROBLEM lV.

PROBLEM
IV.

To perfect a mechanism for starting internal combustion engines with compressed air, which is automatically thrown out of commission when air is turned off, and into commission when air is turned on, and which can only wear when engine is starting.

WHY NECESSARY.

Internal combustion engines, unlike water wheels, windmills and steam engines which get their moving element from an outside source, must be started before they can fulfill their function as prime movers. Small engines of this type are started by hand, by electric motors and by explosions of gunpowder or gas, but large engines whose mechanical friction may equal 1000 B.H.P., to be commercial, must be equipped with a starting device absolutely reliable and of small cost.

Compressed air seems to be the best and only satisfactory medium for large units. It can be stored in tight tanks indefinitely, is ready for use at any time, and can be compressed by a hand started engine, using generally the same fuel as the prime mover which it ultimately starts.

While the tandem double-acting gas engine shown in Figure 1, Problem 1, was started on the Lenoir cycle by giving the pulleys a half turn, it was also equipped for starting with compressed air, and a broad claim covering this principle was granted to the author at that time (Specifications #763983, Claim 3).

In order to start this engine with air, gas and suction pipes are closed to one cylinder, lay shaft for this cylinder is shifted to the Lenoir cycle, and compressed air is admitted around the piston cutoff valve (Specifications #752303, Problem 2), which admits air under pressure to the cylinder

five-eights of the piston travel for every stroke. As soon as the second cylinder operates as a gas engine, air is cut off, lay shaft shifted back and valves opened. Eight operations are necessary where there should be but one.

In order to eliminate the opening and closing of valves and the expense of purchasing them (not inconsiderable when for 10" and 12" pipe) two starting valves (Fig.1), one for each end of head end cylinder were designed, for the details of which see Figure 2, in Specifications #1061249. Normally these valves are out of commission -- the spring K^5 holding the roller H^5 away from the cam D, and the spring J holding the valve I closed to the cylinder A.

While this mechanism was thrown into commission when compressed air was turned on, eliminating six of the eight operations, the device was only adapted for an engine having automatic suction valves, as air was admitted during both the working and suction stroke.

FINAL SOLUTION.

The final solution of this problem (Fig.3) shows a detail of the mechanism involved. This is applicable to any four cycle gas engine having from one to eight explosion chambers. Air pressure is admitted during the working stroke flowing in as soon as the piston starts away from compression and follows to any predetermined point of the stroke.

A represents the inside wall of a cylinder or the outside wall of an explosion chamber; H a valve cage in which the poppet valve stem J slides, carrying the valve J' and on the outer end the nuts J^3. F is a plug valve through which the valve stem J slides, with a grooved collar on the outer end, carrying the forked end of lever D. Between the washer J^2 on the valve stem J, and the shoulder on the inside of the plug valve F is a spring G, which, under normal condition, holds the valve J' closed, and the plug valve collar against cage H at F', and the roller E on D away from the cam C on the lay shaft B.

Fig. 1

In this normal position it is evident that the poppet valve opening into the explosion chamber A will remain closed, and that the mechanism will remain inert. K is an opening into H, controlled by a valve K', which in multi-cylinder engines controls the air for all. Assuming that it is desired to start the engine with compressed air, the valve K' to the air supply is opened, and its pressure tends to compress the spring G, and separate the plug valve F and the poppet valve J', throwing the roller E towards the cam C. If the rise of the cam C is not under the roller E, the plug valve F will move out until the large end strikes the washer J^2, holding the valve J' tight on its seat, thereby preventing air from going into cylinder at the wrong time. When the rise of the cam C, which should be under E when air is to be admitted, raises the roller E, plug valve F leaves washer J^2, permitting the air in I to compress spring G and open the valve J', and to flow into the cylinder during the working stroke. As soon as the rise on C passes E, the roller approaches the normal part of C, holding J' shut during exhaust, induction and the compression strokes.

This starting mechanism in no way interferes with engine operating under normal conditions. If the compression should exceed the air pressure used for starting, valve J' will not open until the compression or even the inflammation pressure drops below that of the compressed air. The air valve may be closed as soon as the engine starts or later; the only advantage in early closing is the saving of compressed air.

With a large reserve, engine may be run on compressed air alone, and has been done in the author's experience while a broken ignition wire has been temporarily repaired.

When air is shut off, starting mechanism draws up out of commission and can not wear.

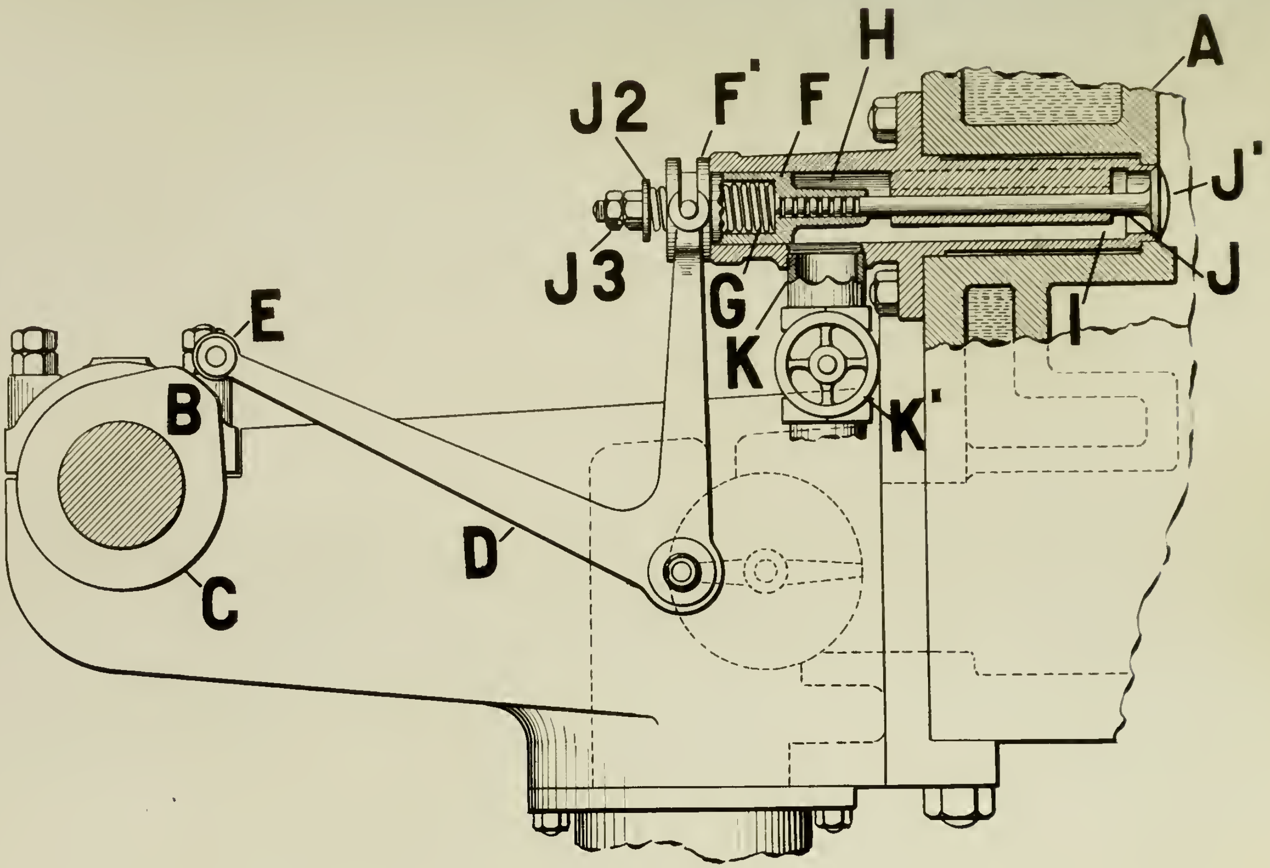


FIG. 3

This principle, in one form or another, is used for starting all makes of large gas engines, and its efficiency is such that one man in one minute can get a 3000 horsepower gas engine running ready for the load.

C. E. SARGENT.

INTERNAL COMBUSTION ENGINE.

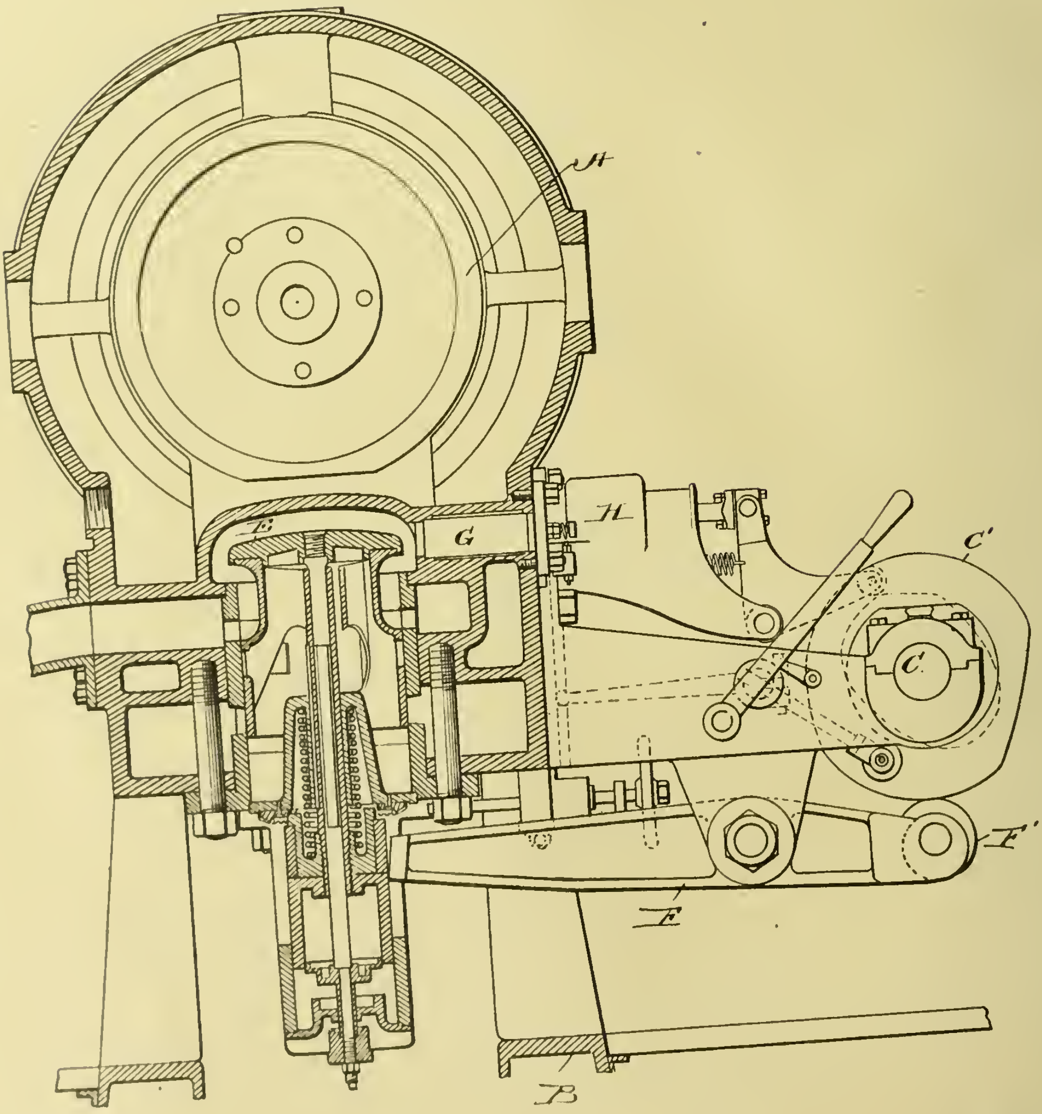
APPLICATION FILED OCT. 7, 1905.

1,061,249.

Patented May 6, 1913.

2 SHEETS—SHEET 1.

Fig. 1.



Inventor

Charles E. Sargent

Witnesses

J. M. Fowler Jr

Jesse C. Miller.

By Wallace Greene, Attorney

COLUMBIA PLANOGRAPH CO., WASHINGTON, D. C.

C. E. SARGENT.
INTERNAL COMBUSTION ENGINE.
APPLICATION FILED OCT. 7, 1905.

1,061,249. Patented May 6, 1913.

2 SHEETS—SHEET 2.

Fig. 2.

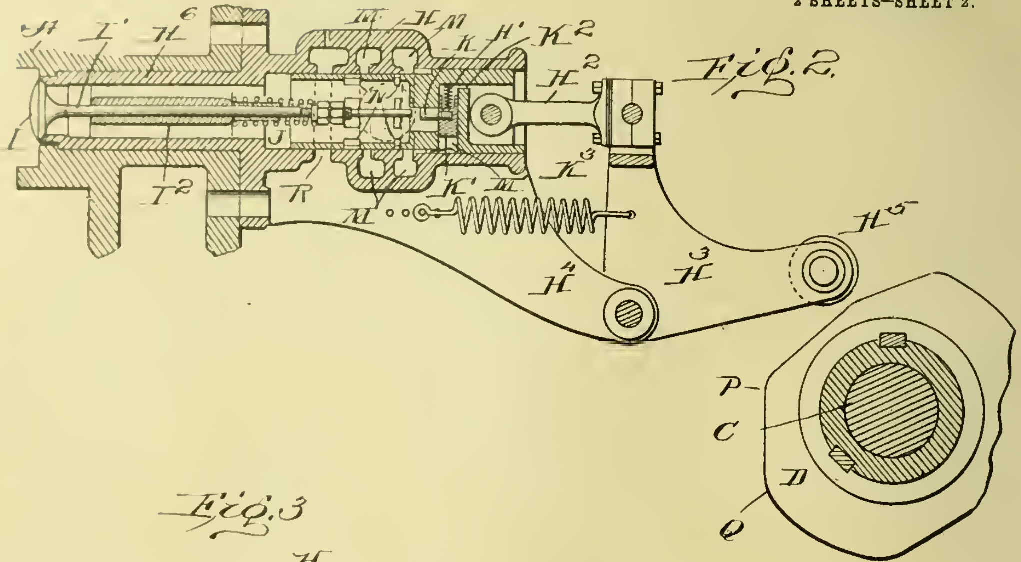


Fig. 3

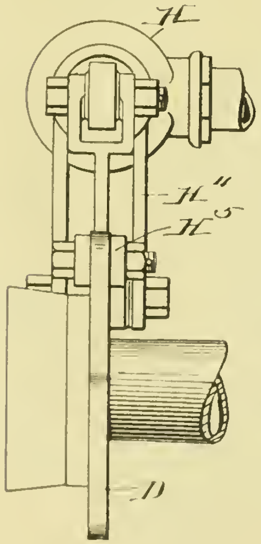
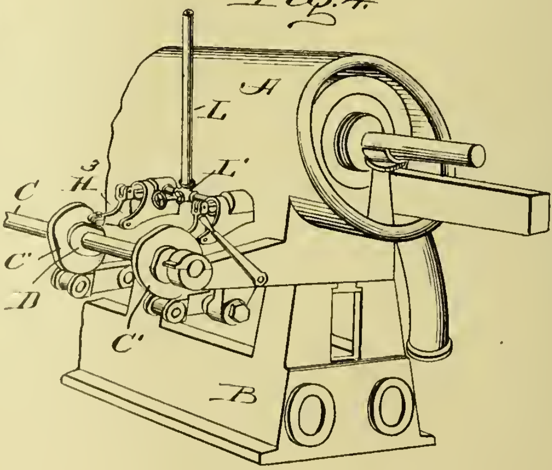


Fig. 4.



Witnesses
J. M. Fowler Jr.
Jesse C. Miller.

Charles E. Sargent. Inventor

By Wallace Greene, Attorney

UNITED STATES PATENT OFFICE.

CHARLES E. SARGENT, OF CHICAGO, ILLINOIS, ASSIGNOR TO SARGENT ENGINEERING COMPANY, OF CHICAGO, ILLINOIS, A CORPORATION OF NEW YORK.

INTERNAL-COMBUSTION ENGINE.

1,061,249. Specification of Letters Patent. **Patented May 6, 1913.**
Application filed October 7, 1905. Serial No. 281,756.

To all whom it may concern:

Be it known that I, CHARLES E. SARGENT, a citizen of the United States, residing at Chicago, in the county of Cook and State of Illinois, have invented new and useful Improvements in Internal-Combustion Engines, of which the following is a specification.

The difficulty in starting very large internal combustion engines is well known and it is now common to employ compressed air, through the agency of somewhat inconvenient apparatus, to put such engines in motion.

The general object of this invention is to provide means whereby the largest engine of this kind may be started as readily and certainly as a steam engine, by merely opening and closing a small valve. With this end in view, the engine provided with admission and exhaust devices without novelty is also provided with independent devices for admitting compressed air, said devices being normally out of action but brought into action by the pressure of the compressed air itself when the latter is allowed to pass a certain valve, and the arrangement is such that when air is thus admitted, the admission of gas or the usual explosive mixture, is automatically prevented as the result of well known physical principles until the air is again cut off. The engine being thus put in motion by the air, cutting off the air supply causes the immediate admission of explosive mixture, and thereafter the engine runs as an internal combustion engine until it is again shut down. In other words, if we have an engine of for example one thousand horse power, the opening of a small air valve puts the engine into action as a compressed air engine, and when the desired speed is reached, shutting off the air automatically causes the engine to change from air to gas as an operating agent.

For the purpose of illustrating my invention, I have chosen a double acting tandem engine having in itself no novelty herein claimed. To this has been added air admitting mechanism involving an admission valve through which air passes directly into the cylinder and an outer valve opened and closed by hand for admitting compressed air to the admission valve and at will cutting it off. The admission valve, which serves also as an exhaust valve, is actuated at proper times by a cam on the usual side shaft, but it remains closed and is in no way affected by this cam except when compressed air is allowed to pass the outer valve; and while air is thus allowed to enter, no explosive mixture enters through the ordinary admission valve, the engine running by compressed air only.

In the accompanying drawings, Figure 1 is a cross section through an engine cylinder, showing an admission and exhaust valve of well known construction actuated by devices without novelty. Fig. 2 is a vertical axial section through certain compressed air mechanism seen also in Fig. 1. Fig. 3 is a view looking from the right in Fig. 2. Fig. 4 is a perspective view of one end of the engine shown in the other figures, the view showing one only of the cylinders of a tandem engine.

In these figures, A represents an engine cylinder supported upon a suitable base B and having the usual side shaft C carrying cams C^1, D, for operating gas and air controlling devices, respectively. As these devices are similar for the two ends of each cylinder, the description of one set only is necessary.

Fig. 1 shows an admission and exhaust valve E, operated by a cam C^1 upon the shaft C, acting through a roller F^1 and pivoted lever F, the entire combination being well known and devoid of novelty, admission being by suction and exhaust by the action of the cam upon the valve operating elements.

For starting the engine, compressed air is admitted to the engine cylinder by independent devices, air entering at G into the space above the valve E temporarily holding the valve closed. In line with the opening G, a casing H is secured, and in this moves a horizontal differential piston valve H^1, connected by a pitman H^2 to a bell-crank lever H^3 pivoted to a bracket H^4 and carrying at its lower end a roller H^5 to rest against the periphery of the corresponding cam D upon the side shaft C. This casing extends inward in the cavity G as a sleeve H^6 and terminates in a seat for a puppet valve I whose stem I^1, sliding in a bearing I^2, projects into the hollow piston valve H^1. A spring J normally holds this valve closed, but it is opened at intervals by two distinct means, as will be seen. A push pin, K, carried by a small piston K^1 moving transversely in a way in the differential valve, normally lies out of alinement with the valve stem I^1 and is held out of alinement by a spring K^2. Normally also, a spring K^3 holds the bell-crank lever lifted so that its roller is out of the path of the cam. As seen in Fig. 4, a valved pipe L between the air mechanism for the two ends of the same cylinder, admits compressed air to both when the valve is opened. The air enters communicating chambers M which receive air through a large inlet shown in dotted lines in Fig. 2, and pushes the piston valve outward, overcoming the force of the spring K^3 and causing the roller H^5 to ride on the cam D, and at the same time enters the space below the piston K^1, lifting the latter and bringing the push pin into alinement with the valve stem I^1. This outward movement of the piston valve brings its unequal ports N into registry with the chambers M, allowing the compressed air to enter the valve and the chamber in which it moves, where it overcomes the force of the spring J and opening the valve I passes into the engine cylinder. The timing of the cam D is such that the air is thus admitted just when the engine piston is ready for its stroke, and the cam is so formed that when a predetermined point of the stroke is reached the cam further lifts the roller, sliding the piston valve inward and cutting off the air. The expansion of the air in the cylinder carries the piston onward to the end of its stroke, and at this point the cam still further raises the roller, so that the push pin K strikes the end of the stem of the valve I, which had closed after the air was cut off, again opening it while the larger of the ports N is in registry with exhaust ports R. This cycle of movements is repeated so long as air is admitted to the chambers M, the admission and exhaust being governed by the cam D and the engine working with perfect regularity as an air engine. During this working as an air engine no gas is admitted for although it would normally be admitted during the first part of alternate strokes, at such times the compressed air is entering the cylinder and no suction is possible. The cam C^1 being all the time in action opens the regular main exhaust at every other stroke, but this opening occurs at the same time as the exhausting through the ports R and consequently the only effect is to in part relieve those ports of their duty at alternate strokes. When it is desired to change from air to gas as an operating agent, or usually as soon as the engine has reached proper speed, it is only necessary to close the air valve L, when the admission valve I closes, the push pin falls out of alinement, and the roller H^5 rises from the cam, the whole mechanism thus passing out of commission. At the same time the momentum of the moving parts, such as pertain to all engines of this class, draws in and compresses a combustible charge, and this being exploded the engine is then and thereafter acting as an internal combustion engine, until it is again shut down.

Obviously the invention is not restricted to use in or with the kind of engine illustrated; and compressed air here represents any fluid under pressure.

What I claim is:

1. The combination with an internal combustion engine and valve mechanism for operating it in the usual manner, of a normally closed valve for admitting air to the engine cylinder, engine-actuated devices normally disconnected during the operation of the engine as an internal combustion engine for opening said valve at intervals, an outer hand valve for admitting compressed air to the valve first mentioned, and intermediate mechanism operated by air from the hand valve to throw said devices into operative connection.

2. The combination with an internal combustion engine, of a valve for admitting compressed air to the space upon the inner side of the gas valve, means for at will admitting compressed air to said air admitting valve and cutting it off therefrom, normally disconnected engine actuated devices for opening the air admission valve at intervals, and means whereby air pressure may connect the disconnected devices.

3. In an engine of the class described having valve apparatus for operating the engine as an explosion engine, the combination with a normally closed valve for admitting compressed air to the engine cylinder, of an engine operated valve-actuating mechanism normally unconnected with said valve, an air operated device, normally out of operative position, for connecting said mechanism and valve, and means for at will throwing said device into operative position.

4. In an engine of the class described having valve apparatus for operating the engine as an explosion engine, the combination with a valve for admitting compressed air to the engine cylinder, a spring normally holding said valve closed during such operation, engine operated mechanism for opening said valve at intervals but normally unconnected therewith during the operation of the engine as an explosion engine, manually controlled means for admitting compressed air to said valve, and means whereby the admitted air connects said mechanism and valve.

5. In an engine of the class described having valve apparatus for operating the engine as an explosion engine, the combina-

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tion with the engine cylinder and a compressed air chamber alongside the same, of a valve controlling communication between said chamber and cylinder, manually operated means for controlling the admission of compressed air to said chamber, devices adapted to control periodic admission of air to and exhaust from said chamber, engine operated mechanism for actuating said valve, and devices, and automatic means for disconnecting said mechanism when air pressure in said chamber ceases.

6. In an engine of the class described having valve apparatus for operating the engine as an explosion engine, the combination with the engine cylinder of a compressed air chamber, alongside the same, provided with inlet and exhaust ports, a reciprocating valve controlling communication between said cylinder and chamber, an engine operated member reciprocating in the line of the valve stem but at some distance therefrom and provided with devices controlling said inlet and exhaust ports, an air actuated device for filling the gap between the valve stem and said chamber, a spring urging said device out of operative position, and manually operated means for controlling access of compressed air to said inlet ports.

In testimony whereof I affix my signature, in presence of two subscribing witnesses.

CHARLES E. SARGENT.

Witnesses:
HARRIETT TAYLOR,
W. T. ANGELL.

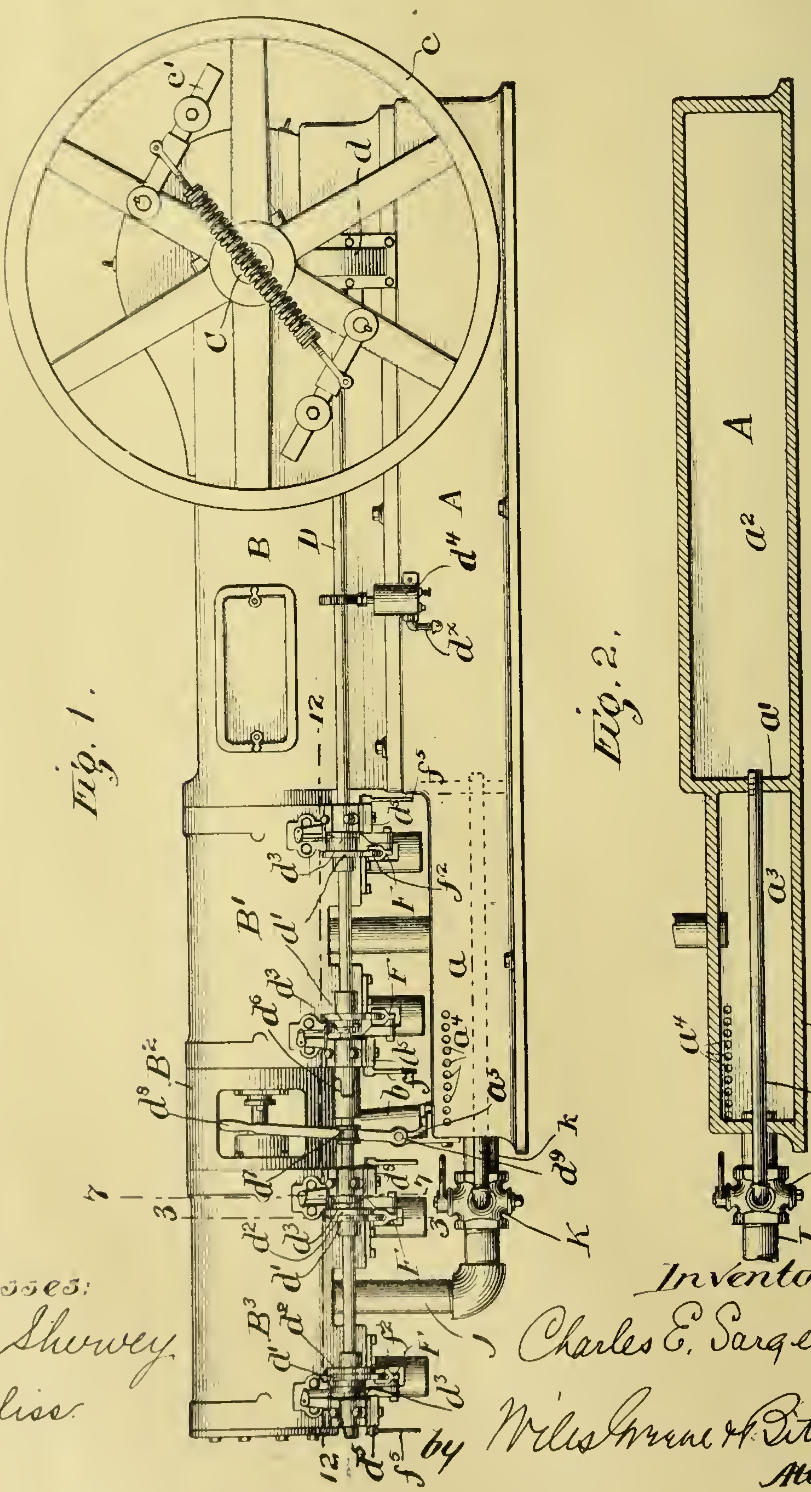
No. 783,983. PATENTED FEB. 28, 1905.

C. E. SARGENT.

GAS ENGINE.

APPLICATION FILED APR. 27, 1900.

4 SHEETS—SHEET 1.



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S. Bliss

Inventor:
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Attys.

No. 783,983. PATENTED FEB. 28, 1905.

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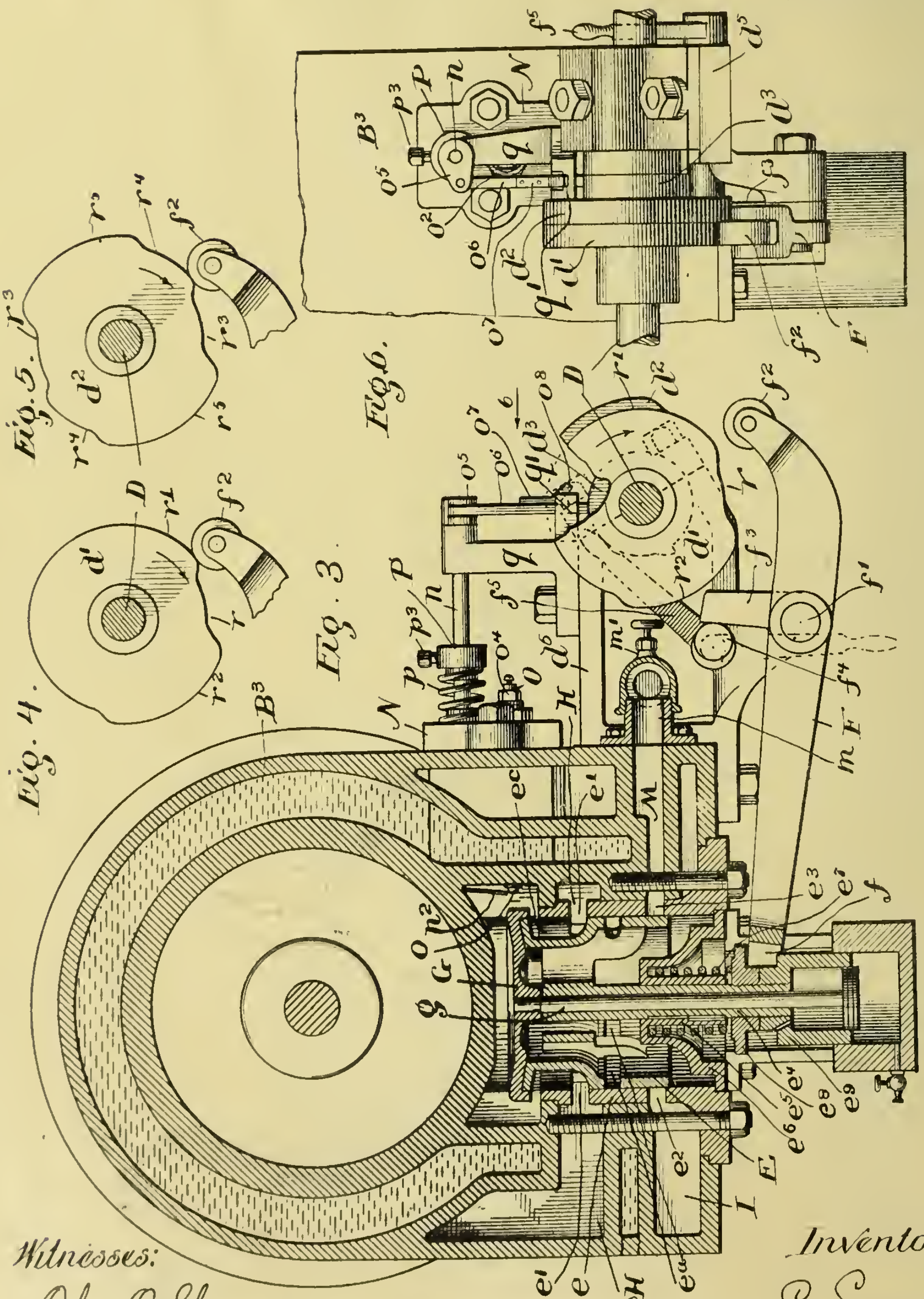
4 SHEETS—SHEET 2.



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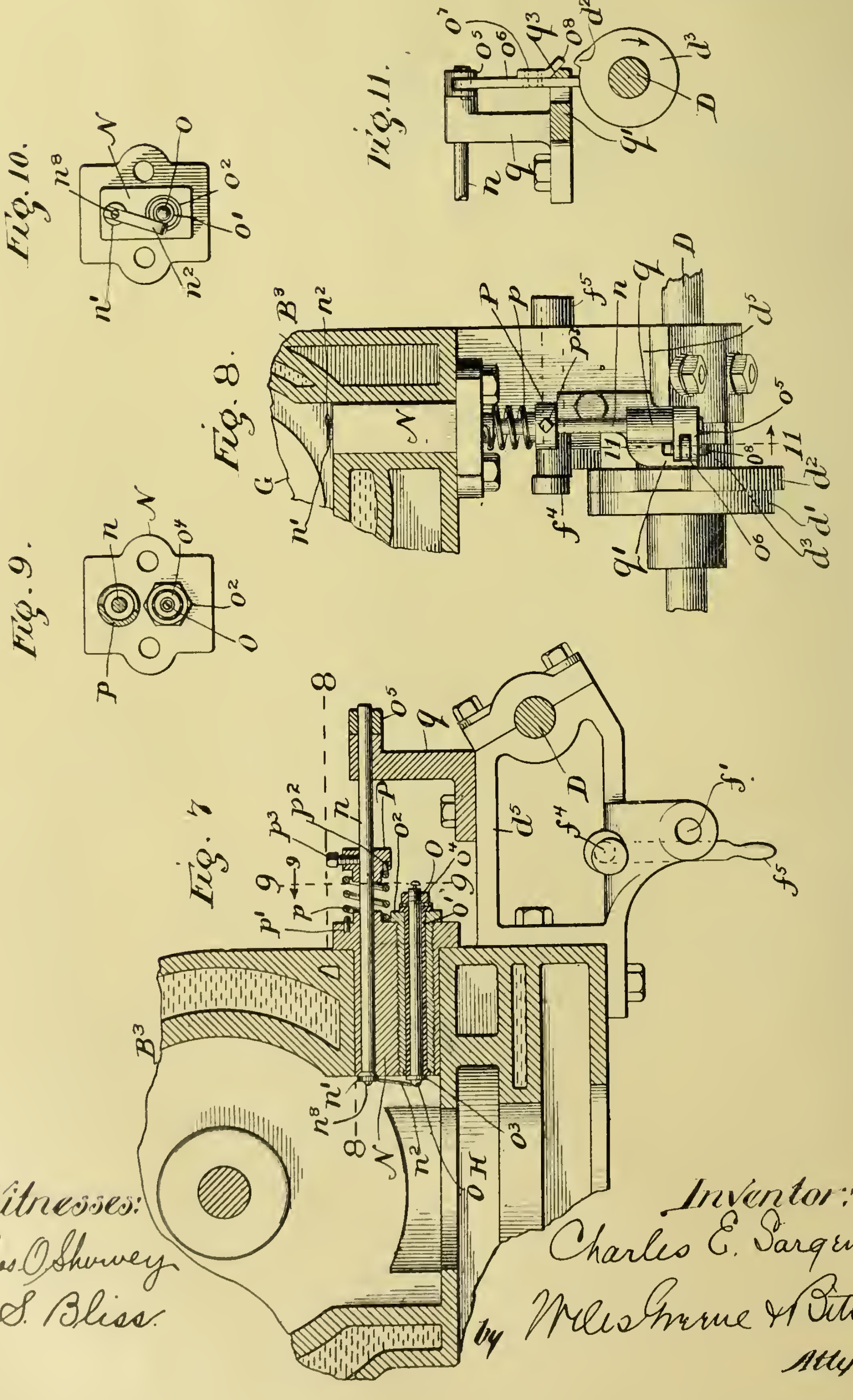
4 SHEETS—SHEET 3.



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4 SHEETS—SHEET 4.

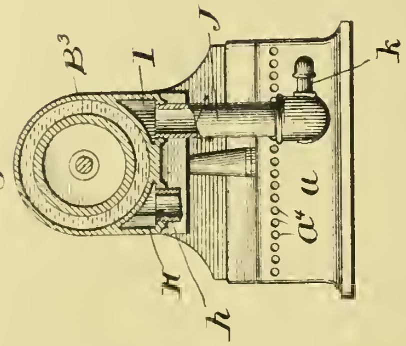

Fig. 13.

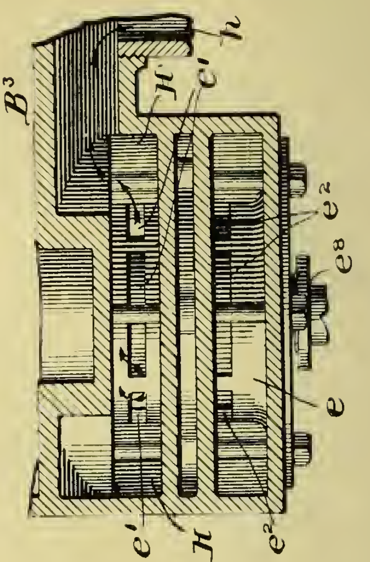

Fig. 15.

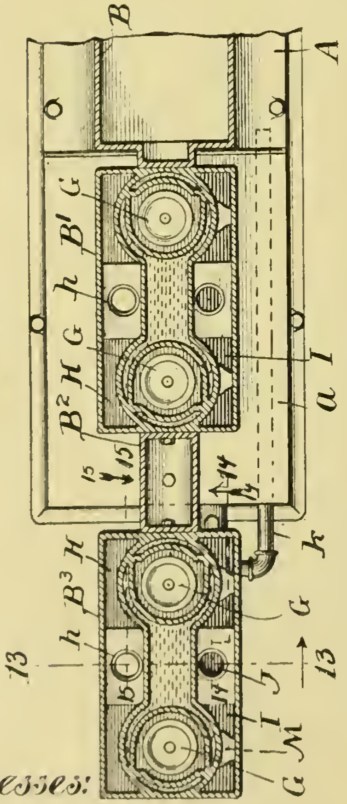

Fig. 12.

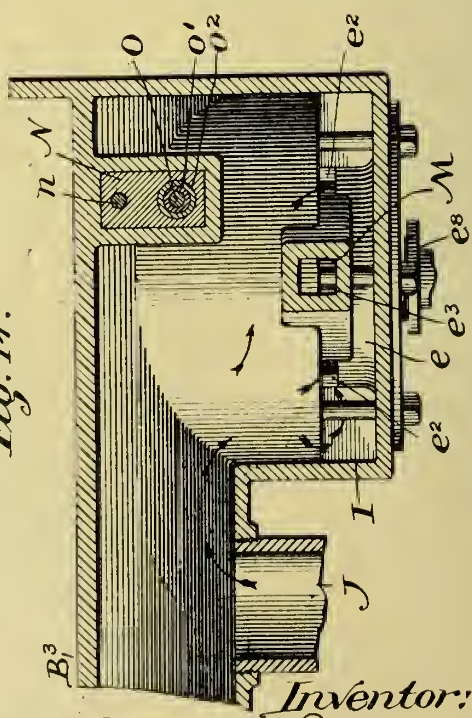

Fig. 14.

Witnesses:

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S. Bliss.

Inventor:

Charles E. Sargent

by Wiles Greene & Bitner.

Attys.

No. 783,983. Patented February 28, 1905.

UNITED STATES PATENT OFFICE.

CHARLES E. SARGENT, OF CHICAGO, ILLINOIS.

GAS-ENGINE.

SPECIFICATION forming part of Letters Patent No. 783,983, dated February 28, 1905.

Application filed April 27, 1900. Serial No. 14,553.

To all whom it may concern:

Be it known that I, CHARLES E. SARGENT, a citizen of the United States of America, residing at Chicago, in the county of Cook and State of Illinois, have invented certain new and useful Improvements in Gas-Engines, of which the following is a specification.

My invention relates to certain improvements in gas-engines designed to render the same more convenient and easy of operation, the invention being directed particularly to certain details, which will be fully described and clearly defined below.

In the drawings, Figure 1 is a side elevation of a complete engine; Fig. 2, a vertical longitudinal section of the base thereof; Fig. 3, a transverse vertical section of one of the cylinders, showing the valve mechanism, the section being in plane 3 3 of Fig. 1 and the view from left to right of the latter figure. Fig. 4 is a side elevation of one portion of the valve-operating cam; Fig. 5, a side elevation of the other portion. Fig. 6 is an enlargement of that portion of Fig. 1 adjacent to one of the valve-operating cams. Fig. 7 is a detail vertical section similar to Fig. 3, but taken in the plane 7 7 of Fig. 1. Fig. 8 is a horizontal section looking downward upon the plane 8 8 of Fig. 7. Fig. 9 is a detail section in plane 9 9 of Fig. 7 looking in the direction of the arrow 9, the view showing merely the outer end of the igniter-supporting block and certain of the parts secured thereto. Fig. 10 is a view of the inner end of said block, showing the same removed from the cylinder and showing the parts upon the inner end of the block. Fig. 11 is a vertical section in line 11 11 of Fig. 8, showing certain details in connection with the igniter. Fig. 12 is a longitudinal horizontal section in line 12 12 of Fig. 1. Fig. 13 is a vertical transverse section in line 13 13 of Fig. 12. Fig. 14 is a longitudinal vertical section in the crooked line 14 14 of Fig. 12 looking in the direction of the arrow 14, and Fig. 15 is a longitudinal vertical section in line 15 15 of Fig. 12 looking in the direction of the arrow 15.

Referring to these drawings, A is a hollow base extended in the form of a subbase a, also hollow and separated from the main portion of the base by a partition a'. Within the main portion of the base is a reservoir a^2, closed with the exception of certain pipes which enter it, and within the subbase is a reservoir a^3, open to the atmosphere through a series of perforations a^4. Upon the base is secured a hollow framework B, extended to inclose the connecting-rod, the crank, and the crank-shaft and supporting suitable bearings for said shaft. The shaft is lettered C and has fast upon it a governor-pulley c, provided with a suitable governor c'. This governor may be of any of the well-known types of gas-engine governors, the object of which is to control the speed of the engine by shifting the time of the opening of the inlet and exhaust ports or by shifting the time of the ignition of the charge. The particular form herein illustrated is that covered by my application for governor for gas-engines, filed April 27, 1900, Serial No. 14,556. The crank-shaft is connected by suitable gearing with a side shaft D, the gearing here being inclosed in a hood or cap d, said side shaft serving to rotate a series of valve-operating cams d' d^2 and a series of igniter-operating disks d^3. It also operates an air-pump of suitable construction d^4. To the end of the frame B is secured one end of a cylinder B', to the other end of which is fastened a distance-head B'', resting upon the subbase by means of a support b and itself carrying another cylinder, B³. To these cylinders are secured a series of brackets d^5, in which the side shaft is journaled. The portion of the shaft alongside of the cylinder B³ is connected to the remainder by a sliding coupling d^6, by means of which the end portion of the shaft is permitted to move longitudinally. The shaft adjacent to this coupling is provided with a groove d^7, with which engages a vertical lever d^8, pivoted at d^9 to a bracket a^5, secured to the subbase. By means of this lever the end portion of the shaft may be moved longitudinally to change the position of the cams $d'd^2$ with relation to the valve-operating devices. One of the valves is shown in Fig. 3 by means of a transverse vertical section. It is located in a valve-chamber beneath the cylinder and works in a vertical cylindrical bushing e, containing exhaust-ports e' and admission-ports e^2 e^3, the latter being for the air and gas, respectively. Within the bushing slides a hollow cylindrical valve E, guided by means of a hollow stem e^4, working in the central boss e^5 of a cap e^6, which closes the lower end of the bushing. The cap extends inward and upward and returns downward in the form of a central boss e^5, which carries a coiled spring e^7, pressing downward upon a nut e^8, screwed to the end of the piston-valve stem and forming, together with a nut e^9 below it on the stem, a means of engagement for the forked end f of a valve-operating lever F, pivoted at f' to the bracket d^5 and carrying at its outer end a roller f^2, adapted to run upon the valve-operating cam. The spring e^7 tends to crowd downward the forked end of the lever and hold the roller upon whichever cam happens to be in position for engagement therewith. The piston-valve contains inlet-ports e^a e^a and has at its upper end an outside groove e^c, adapted when raised into proper position to connect the exhaust-ports e' with the interior of the valve-chamber and with the cylinder. Upon the top of the piston-valve rests a puppet-valve G, guided by a stem g in the hollow stem of the piston-valve and adapted to be raised by pressure below it and forced downward by pressure above it. It is also adapted to seat upon the top of the bushing when the piston-valve is lowered. The exhaust-port e' communicates with a chamber H, which connects, as shown in Fig. 15 and Fig. 13, with an exhaust-pipe h, open to the atmosphere. The inlet-port e^2 connects with a chamber I, communicating with a pipe J, as seen in Fig. 14, said pipe extending, as seen in Figs. 1 and 2, into the subbase a, so as to be open to the atmosphere through the perforations a^4. The pipe J contains an ordinary three-way valve K, adapted to cut off the connection with the subbase and at the same time establish connection with a branch pipe k, opening into the reservoir a^2 of the main portion of the base, as seen in Fig. 2.

The admission-port e^3 connects with a chamber M, from which a pipe m, containing a stop-cock m', leads to a suitable reservoir for a supply of gas or other combustible material.

The valve-operating levers F have vertical arms f^3, adapted to be engaged by eccentrics f^4, rotated by levers f^5 and suitably supported and pivoted upon the brackets d^5. These eccentrics are intended to bear upon the arms f^3 to oscillate the levers sufficiently to hold the rollers away from the cams and the valves in their uppermost positions, in which the exhaust ports and passages are open between the cylinder and the atmosphere.

The shape of the cams d' d^2 is shown in Figs. 4 and 5. The cam d' is shown in Fig. 4 and bears a depression r, which enables the roller to rise and the valve to drop so as to open the inlet-ports during part of the admission-stroke. As the cam advances in the direction of the arrow the portion r' engages the roller and holds the valve so as to close both the inlet and the exhaust ports during whatever remains of the admission-stroke, all of the compression-stroke, and the working stroke of the engine. The raised portion r^2 then crowds the roller down, raising the valve to open the exhaust-port during the exhaust-stroke. The cam d^2 has two depressions r^3 upon opposite sides, which allow the inlet-ports to open at the commencement of each forward stroke of the engine, two opposite portions r^4, which close both the inlet and exhaust ports during the remainder of each forward stroke, and two opposite portions r^5, which hold the exhaust open during each entire backward stroke of the engine.

The air-pump d^4, operated by the side shaft D, forces air through a pipe d^x into the reservoir a^2 within the hollow base, said air being for use in starting the engine, as hereinafter described.

A block N (see Fig. 10) is let into the side of the cylinder, as seen in Fig. 7, terminating within the latter in the valve-chamber, and said block contains a rock-shaft n, terminating at the inner end of the block in a coned enlargement n', seated in the block and bearing a wiping spring-arm n^2, brought by the rocking of the shaft into contact with the inner rounded end o of an electrode O, the outer end of which is connected with a suitable source of electricity. The electrode is inclosed in an insulated bushing o', itself inclosed in a screw-plug o^2, threaded in the block, the electrode being held within the bushing by means of a head o^3 at the inside end and a nut o^4 bearing upon the outside end of the bushing. The electrode is cylindrical in form, so as to be rotatable in the bushing to bring new portions of its surface into contact with the wiping-arm. The elasticity of the spring-arm causes the latter to bear with a yielding force upon the inner end of the electrode and make a perfect contact therewith. Upon the portion of the rock-shaft n without the cylinder is a coiled spring p, having one end, p', fastened in the block N and the other end fast at p^2 in a collar P, secured by a set-screw p^3 to the shaft and adjustable both longitudinally and angularly upon the latter. The spring p is put under torsional and longitudinal tension, so as to draw the coned end n' of the rock-shaft to its seat and also to turn the wiping-arm n^2 away from the electrode O. Upon the outer end of the rock-shaft is secured a crank-arm o^5, (best seen in Fig. 6,) to the outer end of which is secured a push-bar o^6, (see Fig. 11,) resting upon the igniter-operating disk d^3.

This end of the rock-shaft is pivoted in a bracket q, the lower part of which has a slotted extension q', (see Fig. 11,) beveled at q^3, and a plate o^7, secured to the side of the push-bar, is bent at an angle at o^8 to engage this beveled part of the bracket. The slot in the bracket extends backward from the push-pin sufficiently to allow a limited movement of the latter in the backward direction. The push-pin is raised by means of a lug d^2, inclined upon the forward side with reference to the direction of movement of the cam and abrupt upon the rear side. This lug raises the push-pin against the tension of the spring p to bring the wiping-arm into contact with the electrode, and as the push-pin rides off of the top of the lug the contact is abruptly broken, causing the spark. In case of a backward movement of the igniter-disk the push-pin is crowded backward by the lug d^2, which, it will be seen, has one sloping side and one radial side, and is raised by the bent portion o^8 of the plate o^7 sufficiently to clear the top of the lug. The lug d^2 presses the push-pin backward, and the wedging action of the bent portion o^8 against the beveled portion of the frame q^3 will raise the push-pin exactly as if the igniter-disk were revolving in the proper direction and the pin had been merely forced upward by the wedging action of the igniter-disk. The wiping-arm n^2 is secured to the inner end of the rock-shaft by means of a screw n^8, so as to be removable therefrom for repairs or in case it needs to be replaced by a new one.

During the ordinary working of the engine the air-pump d^4 forces air into the reservoir a^2, so that a supply of compressed air is always stored inside the reservoir with which to start the engine. To do the latter, the lever d^8 is thrown to the left, bringing the cams d^2 upon the left-hand cylinder beneath the rollers f^2 corresponding thereto. The levers f^5, corresponding to the right-hand cylinder, are raised into the position shown in Fig. 3 to open the exhaust-valves of said cylinder. The pulley is turned until one of the depressions r^3 upon the cam d^2 at one end of the cylinder B^3 passes beneath the roller f^2 and permits the inlet-ports to open. The three-way cock K is turned to open communication between the reservoir a^2 and the valve, and the compressed air rushes into that end of the cylinder B^3. The corresponding cam at the other end of the cylinder is so arranged upon the shaft as to bring one of its exhaust portions beneath the roller at this time and open the exhaust-port at that end of the cylinder. The air drives the piston forward, is cut off at part of the stroke, expands during the remainder, and at the commencement of the return stroke is allowed to escape through the exhaust-valve, which is opened by the portion r^5. When this occurs, the inlet-valve at the opposite end of the cylinder is open and the movement is reversed. This is continued until the compressed air brings the engine up to speed in the manner of the ordinary compressed-air or steam engine. After this has been accomplished the handle d^8 is swung into the position seen in Fig. 1 and the parts are ready to operate as in a four-cycle engine. Thus in starting air may operate one cylinder while the piston of the other runs idle, the exhaust-valves being open, and when proper momentum has been attained the valves of the second engine may be shifted and that cylinder may be brought into action as a four-cycle engine, if desired, without meantime ceasing to operate the other by compressed air.

The igniter and the actuating devices therefor shown and described in this specification are not claimed herein, inasmuch as the same have been made the subject of a divisional application, filed November 3, 1900, Serial No. 35,371.

The above description has been made as specific as possible in order that it may be perfectly clear; but it is not the intention to thereby limit the invention in any manner to the exact details described, nor to any arrangement or combination of the same, except such as is hereinafter set forth.

I claim as new and desire to secure by Letters Patent—

1. In an internal-combustion engine, the combination with a combustion-cylinder having a valve-chamber, of a cylinder-valve lying in one part of the chamber and controlling the inlet and exhaust passages, an ignition device lying in another part of the chamber, and an independently-movable puppet-valve for closing communication between the two parts of the chamber.

2. In an internal-combustion engine, the combination with two tandem double-acting cylinders, a single piston-rod, two pistons mounted on said rod and playing in said cylinders, an explosion-chamber in each end of each cylinder, a combined piston and puppet-valve in each of said explosion-chambers, with suitable devices for actuating the valves of one cylinder so as to produce a compressed-air engine and actuating the valves of the other cylinder as a four-cycle engine, substantially as described.

3. The combination with two tandem cylinders each having an explosion-chamber in each end, of two pistons carried upon a single piston-rod and each separating the explosion-spaces in one of the cylinders, suitable valves for each cylinder, means for operating each cylinder as a four-cycle cylinder, and means for at will operating one cylinder as a compressed-air engine.

4. In an internal-combustion engine, the combination with an engine-frame, tandem cylinders, a hollow inclosed base, a side shaft,

an air-pump operated by said shaft, a reservoir for compressed air, suitable connections between said pump and said reservoir, and a three-way cock connecting one cylinder with the reservoir and with the atmosphere as desired, substantially as described.

In witness whereof I have hereunto set my hand, at Chicago, in the county of Cook and State of Illinois, this 19th day of April, A. D. 1900.

CHARLES E. SARGENT.

Witnesses:
CHAS. O. SHERVEY,
S. BLISS.

PROBLEM V.

PROBLEM
V.

To construct a device which will, without moving mechanical parts, (a stipulation laid down by Fire Underwriters in making rules for the installation of sprinkler apparatus) indicate a change in head of one pound pressure or less, by lighting a lamp or ringing a bell.

WHY NEEDED.

In fire protection service where sprinkler systems, water tanks and stand pipes are interconnected, it is necessary to maintain within a few inches a certain head of water, and to signal the main office or start a pump when this head rises or falls beyond the prescribed limits.

On account of pressure gages, such as diaphragm and Bourdon springs becoming set and the mechanism deranged, the Underwriters specify that signaling apparatus shall be provided without moving mechanical parts. Such apparatus must be accessible for inspection, must show the pressure maintained, and is limited in height to eight inches (8").

SOLUTION.

The solution of this problem is shown in Fig.1, and in the accompanying specifications No.785438. For example; it is desired to maintain a head of water in a tank at some predetermined pressure with a variation of not to exceed one pound either way, and if the pressure drops below this limit, or goes above it, to give an alarm or start a pump.

The capacity of the air receptacles B and D, and the capillary tube C is such that when the predetermined pressure is reached in A, the mercury will have reached the bottom of the tube C, and a slight additional pressure in A will send the mercury up to D. At EEE platinum wire is fused in the capillary tube so that an electrical contact can be made or broken with the slightest change in

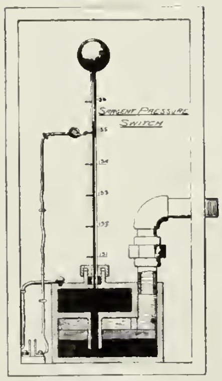


Fig.7

the head. By varying the calibre of the tube any degree of regulation may be obtained. In practice it was found that a slight oxidization would take place at the platinum points when current was broken, which in time tended to short circuit the connections, even though the head of mercury was below the platinum point. This was overcome by using pure Nitrogen above the mercury.

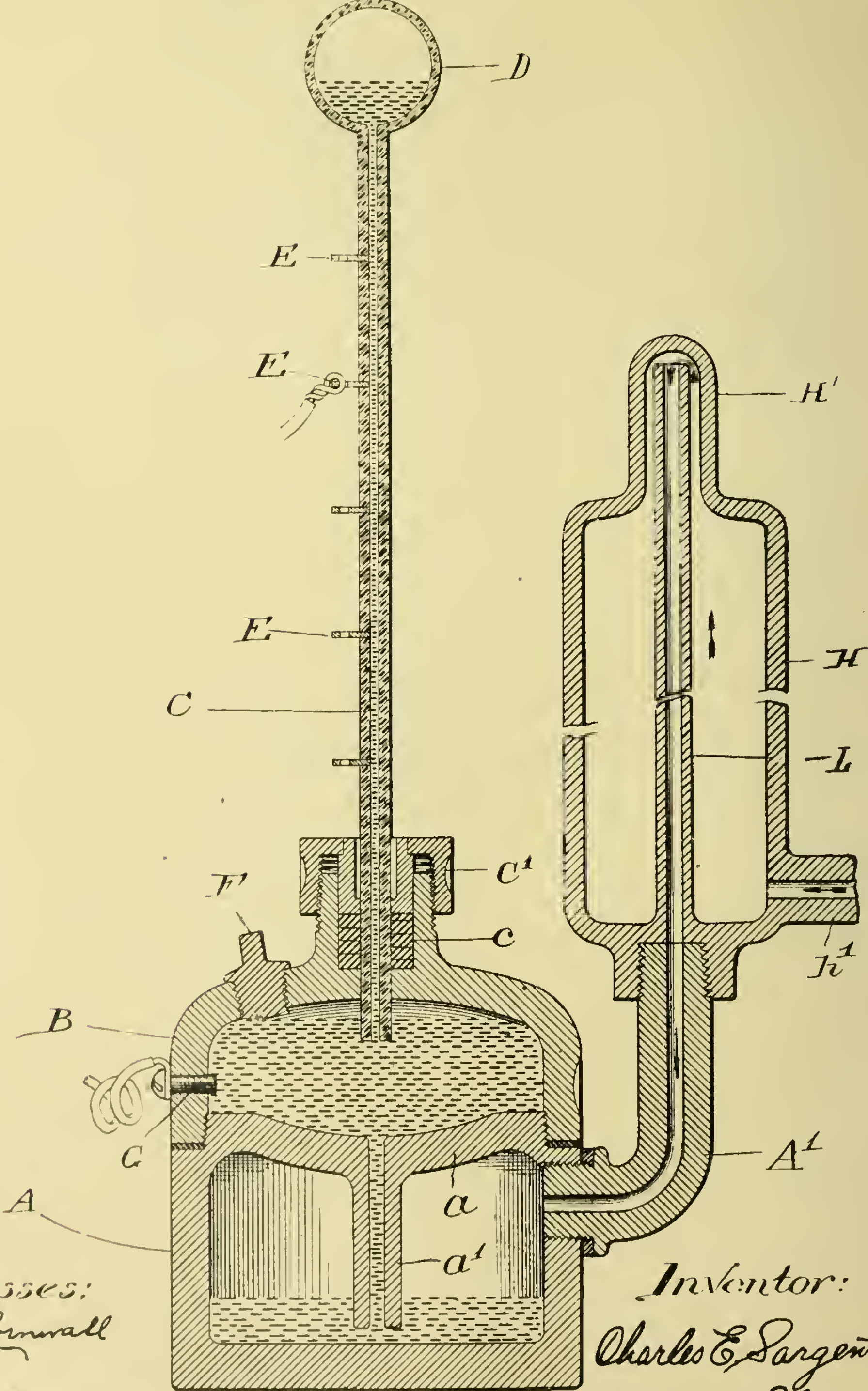
It is evident from the description, and from Boyle's law, that the device could be so proportioned that for 200 pounds pressure mercury would rise to the lower end of the tube C, and for 201 pounds it would reach to the receptacle D, and that any intermediate pressure can be obtained.

No. 785,438. PATENTED MAR. 21, 1905.

C. E. SARGENT.

PRESSURE GAGE.

APPLICATION FILED SEPT. 24, 1904.



Witnesses:
K. M. Cornwall
J. E. Sherwey

Inventor:
Charles E. Sargent,
by Bitner, Wiles & Sherwey,
Attys.

United States Patent Office.

CHARLES E. SARGENT, OF CHICAGO, ILLINOIS.

PRESSURE-GAGE.

SPECIFICATION forming part of Letters Patent No. 785,438, dated March 21, 1905.

Application filed September 24, 1904. Serial No. 225,734.

To all whom it may concern:

Be it known that I, Charles E. Sargent, a citizen of the United States of America, residing at Chicago, in the county of Cook and State of Illinois, have invented certain new and useful Improvements in Pressure-Gages, of which the following is a specification.

My invention relates to certain new and useful improvements in pressure-gages; and its object is to produce a device of this class which shall have certain advantages, which will appear more fully and at large in the course of this specification.

To this end my invention consists in certain novel features, which are described herein and illustrated in the accompanying drawing, which represents a vertical section through my improved device.

Referring to the drawing, A is a mercury-chamber, preferably made of some non-conducting material. The chamber has a top *a*, from which a tube *a'* extends downward, terminating just above the bottom of the chamber. An inlet-pipe A' opens into the mercury-chamber at one side. A cap B is screwed over the top of the mercury-chamber, and the said cap, together with the said top of the mercury-chamber, forms a compression-chamber. A tube C extends through the cap B into the compression-chamber and is held in place by packing *c*, held under compression by a thimble C'. The tube C is provided at its top with a bulb D and along its side with a plurality of contact-points E. A plug F is provided to give access to the chamber, and a contact-point G, entering the liquid, is secured to the mercury-chamber.

In practice the mercury-chamber A is filled with mercury approximately to the level of the bottom of the compression-chamber, and pressure is applied to the inlet-pipe A'. As the pressure increases it is transmitted by the mercury to the air in the compression-chamber, tube, and bulb, which of course is compressed, in accordance with Boyle's law, affording a space for the rise of the mercury in the compression-chamber. The mercury reaches the lower end of the tube C just before the pressure which the gage is intended to indicate is reached. As the pressure increases from this point the mercury rises very rapidly through the length of the tube and passes in succession the contact-points therein, any or all of which may be connected with electrical apparatus, as desired. Still further increase of pressure will cause the mercury to enter the comparatively large bulb at the top of the tube, and its further rise will become very slow indeed.

My improved device is particularly designed for use and in connection with automatic sprinklers and the like, where it is necessary that a continuous high pressure of water be maintained. The parts are arranged so that the normal pressure holds the mercury just within the bulb and keeps the electrical circuit closed. If for any reason the pressure is diminished, the mercury falls in the tube and opens the circuit, thereby starting the pumps, which raise the pressure until the circuit is closed.

The tube C is made adjustable in the compression-chamber, so that the point at which the mercury reaches the tube can be varied to accommodate the device to systems of standard pressure.

In some cases it may be desirable to prevent the grounding of the electrical circuit through the water of the pressure system. To produce this result, it is desirable that the water be removed from contact with the mercury, and this is accomplished by means of a chamber H, interposed between the inlet-pipe A' and the water-pipes of the system. This chamber, it will be seen, has a long tube *h*, which is practically a continuation of the inlet-pipe A', and a pipe *h'* is provided at the lower end of the chamber H, which can be connected with one of the water-pipes of the pressure system. The pressure of the water will then be transmitted through the air in the chamber H to the mercury, and the water itself will never come in contact with the mercury. The chamber H is made of sufficient size that the water will never rise above the end of the tube *h*, and the upper end of the chamber H is constricted at the end H' to prevent water from splashing over the end of the tube, and so reaching the mercury.

It will be evident that many variations in the construction of my device are possible and that any desired liquid can be substituted for mercury, although I greatly prefer mercury on account of its superior advantages as an electrical conductor. My device is particularly advantageous because of the fact that the device is of small size, and the rapid movement of the indicating medium is obtained at and near the point when accurate indication is desirable and comparatively slow movement is obtained elsewhere.

I realize that considerable variation is possible in the details of this construction without departing from the spirit of the invention, and I therefore do not intend to limit myself to the specific form herein shown and described.

I claim as new and desire to secure by Letters Patent—

1. In a device of the class described, the combination with a chamber for containing liquid and an inlet-pipe opening into the same, of a compression-chamber opening into the lower part of the said liquid-chamber, containing a tube extending upward from said compression-chamber, and a comparatively large bulb at the upper end of said tube.

2. In a device of the class described, the combination with a chamber for containing liquid and an inlet-pipe opening into the same, of a compression-chamber opening into the lower part of said liquid-containing chamber, a tube of small diameter extending from the top of said compression-chamber, and a comparatively large bulb at the upper end of said tube.

3. In a device of the class described, the combination with a liquid-containing chamber and an inlet-pipe opening into the same, of a compression-chamber above the liquid-containing chamber, a tube extending downward from the bottom of the compression-chamber to the lower part of the liquid-containing chamber, a tube of small diameter extending from the upper part of the compression-chamber, and a bulb at the end of said second tube.

4. In a device of the class described, the combination with a liquid-containing chamber and an inlet-pipe opening into the same, of a compression-chamber above the liquid-containing chamber, a tube extending downward from the bottom of the compression-chamber to the lower part of the liquid-containing chamber; a tube of small diameter extending from the upper part of the compression-chamber, a bulb at the end of said second tube, and means for adjusting said second tube within said compression-chamber.

5. In a device of the class described, the combination with a mercury-chamber and inlet-pipe opening into the same, of a compression-chamber above the mercury-chamber, a tube extending downward from the compression-chamber to the lower part of the mercury-chamber, a tube extending upward from the upper part of the compression-chamber, a contact-point in the second tube, and a bulb at the upper end of the second tube.

6. In a device of the class described, the combination with a mercury-chamber and inlet-pipe opening into the same, of a compression-chamber above the mercury-chamber, a tube extending downward from the compression-chamber to the lower part of the mercury-chamber, a tube extending upward from the upper part of the compression-chamber, a plurality of contact-points in the second tube, and a bulb at the upper end of the second tube.

7. In a device of the class described, the combination with a mercury-chamber, and an inlet-pipe opening into the same, of a compression-chamber above the mercury-chamber, a tube extending downward from the compression-chamber to the lower part of the mercury-chamber, a tube extending upward from the upper part of the mercury-chamber, a contact-point in the second tube, a bulb at the upper end of the second tube, an inlet-pipe opening into the mercury-chamber, an air-chamber opening into the said inlet-pipe and a tube communicating with the inlet-pipe, and extending to the top of the air-chamber.

In witness whereof I have signed the above application for Letters Patent, at Chicago, in the county of Cook and State of Illinois, this 21st day of September, A. D. 1904.

CHARLES E. SARGENT.

Witnesses:
RUSSELL WILES,
CHAS. O. SHERVEY.

PROBLEM VI.

PROBLEM
V1.

To bring out an instrument which will indicate the angular velocity variation of a flywheel during a revolution, a mechanical umpire, as it were, between engine and generator builders when parallel operation must be attained.

WHY NEEDED.

When alternating electrical apparatus began to be used for central stations, reciprocating engines were the only prime movers except water wheels which could be obtained to drive them.

When alternators are used in parallel to deliver current to the same bus bars, they must work in harmony or unison, or there will be a surging of current from one to the other which causes overheating, a loss of energy and sometimes a flash-over when the two or more machines get out of step. The more uniform the turning moment, the more successful is parallel operation.

In order to get a satisfactory prime mover to drive the electric generator, its manufacturer specifies that the engine shall not vary from a uniform speed more than a certain number of electrical degrees during a revolution. When the number of poles on the generator and the cycle are known, this limit can be transformed into geometrical degrees.

All reciprocating engines, either steam, gas or oil, have a variable speed during each revolution. Other things being equal, the more cranks or impulses equally spaced, or the heavier the flywheel, the less the angular velocity variation.

The engine builder furnishes a flywheel which calculations have shown meets with the electrical manufacturers' requirements, but when generators do not parallel as they should, when large quantities of current

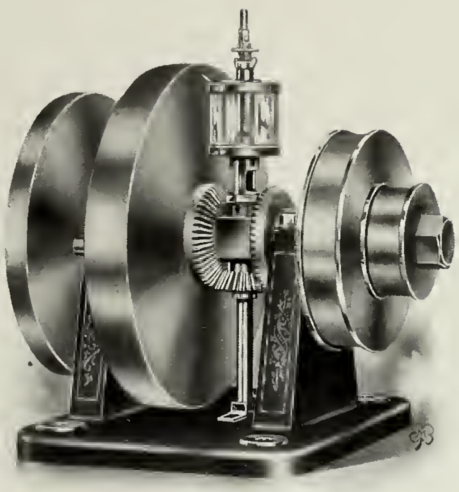


Fig. 1

Fig. 2

flow from one generator to another, then the question arises,- is it the generator or the engine man's mistake? A consulting engineer may have to locate the fault, and act as an umpire for the purchaser between the engine and generator companies.

SOLUTION.

An instrument to indicate the angular velocity of a flywheel to be commercial should be portable, accurate and applicable to any prime mover. Such an instrument is illustrated in Figs.1 and 2.* The principle of operation is that if a light wheel is driven by an inelastic flexible belt from a prime mover, the light wheel will parallel the angular variations of the engine driving it. Now if the light wheel drags a comparatively heavy flywheel through a spring, the flywheel should have a uniform turning moment. In the construction the flywheel is kept in motion by the tension of the hair spring under the needle (Fig.2). The belted wheel drives through the bevel gear (Fig.1) the bevel pinion, which in turn drives the second bevel gear and flywheel in an opposite direction. The hair spring tends to hold the pinion shaft vertical, and if the belted pulley accelerates, the bevel pinion shaft will have one half the advance, which is multiplied 100 times and transmitted to the needle on the dial. By using a driving pulley on the engine shaft of the right diameter, the amplitude of the needle will indicate the geometrical minutes and seconds variation of the engine during a revolution. When used with an internal combustion engine, missed ignitions are indicated on the Anglemeter dial by exaggerated movements of the needle, often moving through one-half of the circumference or a full geometrical degree.

This instrument has been used by the author for the purpose for which it was designed for about fifteen years.

*For a complete description of the construction of the Anglemeter see Volume 24 of the Transactions of the American Society of Mechanical Engineers.

PROBLEM Vll.

PROBLEM
V11.

To devise an attachment for steam, air or gas pipes which would indicate the pounds avoirdupois of steam, air or gas flowing through, irrespective of pressure, i.e., a Flow Meter.

REASONS FOR ITS EXISTENCE.

Being called upon a few years ago to determine the amount of steam a large baking company in Chicago was using for heating, in order to prorate the cost of its generation with that of another tenant using steam for heating and elevator service, the author realized the necessity of a device which would indicate the pounds of steam flowing through a pipe, or at least the rate at which it was flowing per hour. Having but one day to get ready to determine that for which the author was retained, the plant was examined and it was found that all the steam used by the baking company flowed through a two inch pipe, while a four inch pipe carried steam to the heating system and elevator engine of the other tenant. The manager of the bakery believed that his steam through a two inch pipe should cost but half as much as the tenant's steam which came through a four inch pipe, and as both parties agreed to abide by the author's decision, guess work was out of the question, and shutting down either the bakery or the other tenant's shop was impracticable.

After careful inspection and estimating the radiating surface of the bakery heating system it was estimated that all the steam used therein would flow through a half inch opening with but a few pounds drop in pressure. During the night steam was cut off sufficiently long to tap a hole for a quarter inch cock each side of the flanged union, and the flanged joint was broken and a steel plate having a half inch hole in center was inserted. By weighing the water that went into the boilers, and by computing the steam that flowed through the

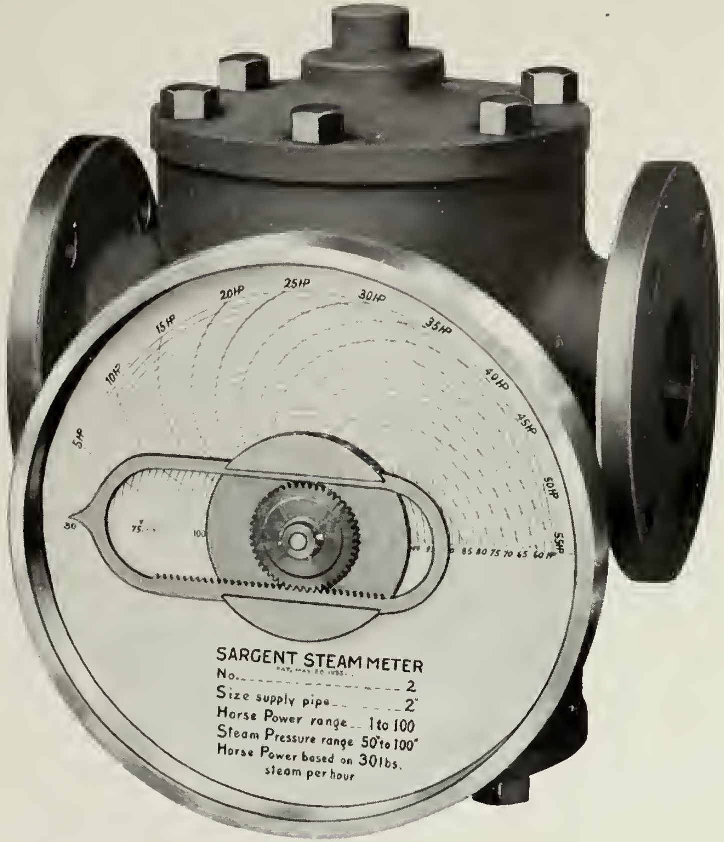


Fig. A

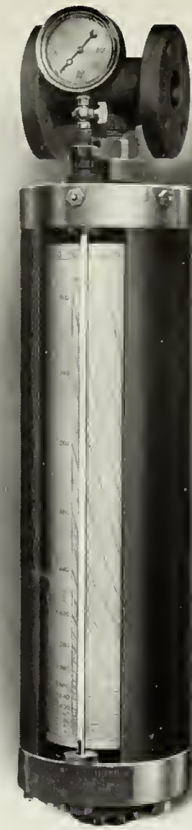


Fig. C

Fig. B

half inch hole by the difference in pressure, and by checking the steam gages by transposing them twice during the eight hour run, the proportion of steam used by the bakery was ascertained, and the expense of the steam proportioned in a satisfactory manner.

As many Chicago concerns were buying steam, the author was impressed with the necessity of a steam metering device which could be sold to landlords or tenants. Steam, like electricity, at that time was sold on a flat rate, and when a room was too hot the windows were opened, and the electric lights were burned by day and night.

To meter steam or air with a varying pressure was considered at that time a most intricate problem. The New York Edison Company which had contracted about that time for large quantities of steam for heating, used for a meter a heavy conical plug in a conical opening, the size of which, as more or less steam passed up and around this plug, would be in proportion to the quantity of steam going through. Knowing the steam pressure on both sides, and the size of the opening, the pounds avoirdupois of steam flowing through per hour could be ascertained.

SOLUTION.

The problem of making a steam meter which would indicate or show on its face the amount of steam passing through irrespective of the pressure was solved by the apparatus shown in Fig.A and accompanying specifications No.729511.

This meter was inserted in any steam pipe having the same diameter as the opening in the meter, and indicated the flow of steam in pounds per hour with a varying or constant pressure.

Instead of depending on gravity working against pressure to regulate the height of the valve between the inlet and outlet side of meter, the pressure of the steam in the outlet side, upon the area of the valve stem (Fig. 2) tends to close the valve, while the pressure on the under and inlet side of

valve tends to raise it.

As the area of the valve stem is two per cent of the area of the valve, it follows that in operation there is a difference of two per cent between the inlet and outlet pressures. The opening or the rising of the valve and stem is transmitted through the yoke, segment and shaft to the pointer G, which rotates on its center as the valve rises, indicating the quantity of steam flowing through.

In the stem there is a piston, the top of which is in communication with the steam flowing through meter, and is held against steam pressure by a spring which shortens as the pressure increases. The piston rod through a yoke, segment, pinion and shaft rotates the gear wheel e' inside the needle (Fig.1) moving the point g' with a change in pressure. In Fig.1 it will be noted that the range of pressure is from fifty pounds to one hundred pounds, and the rate of flow per hour is from zero to three thousand pounds avoirdupous. If the meter is in the line and the pipe is filled with steam at fifty pounds gage, the pointer G will stand as shown. If the pressure increases to one hundred pounds the point g' of pointer will move towards the center until the one hundred pound circle is reached. If the pressure remains at fifty pounds and steam is flowing through the meter, g' will rotate on the fifty pound circle.

Now if PV equals a constant, we increase the pressure and decrease the opening to get through the same amount of steam per hour, therefore to read the meter note the position of point g' and follow the curved line on which it rests to the outer semi-circle where the rate of flow is shown. This meter gave excellent and accurate results when new, but the continual movement of the mechanism between the valve and the spring and the pointer soon wore the segment gears and pinion, causing lost motion and incorrect indications.

While steam is supposed to be pure water, in time it carried enough entrailed moisture with its lime and mineral matter to stop the action of the piston in the hollow stem.

About a dozen flow meters of this type were put out on test, but all sooner or later were found unsatisfactory. While the theory seemed all right, practically the meter was a total failure, and the problem of designing a flow meter without segments, pinions, helical springs and pistons was solved in the meter, Fig.B, with details and description No.883670. The Bourdon spring takes the place of the helical spring and piston. The taper valve with taper seat gives great valve movement for a small opening of valve. The rise of the valve shows volume on the dial, and the horizontal movement shows pressure. The long valve stem with water grooves made an excellent seal, but in a few years time the mineral matter would stick to the stem, and in time put this meter out of commission. About three hundred were sold and many have been in operation for ten years, but on the whole the meter is not a commercial success.

Meters heretofore described were inserted in the steam pipe, and were in larger sizes exceedingly heavy, as they had to carry modern steam pressures, and were expensive to build, to calibrate and to install.

A six inch meter (Fig.B) weighed over eight hundred pounds.

To make a successful and commercial steam meter past experience indicated that it must have no moving mechanism which could become inoperative by the mineral matter in steam, that it preferably should work on a shunt instead of being in the path of all the steam, and that to be commercial one size of instrument should be applicable to all sizes of pipes.

The solution of this problem was the Pitot Steam Meter (Fig.C; details and description No.886255). The amount of steam passing through a pipe equals the velocity times the area - $\sqrt{2gh} \times \pi R^2$. The meter consists of two Pitot tubes within the steam pipe, the one facing the steam at about two-fifths of the diameter of the pipe, or extending across the steam pipe with several openings facing the steam, either of which gives the average velocity, and the other opening at right angle to the direction of flow. The tube facing the flow

terminates at the top of a well of mercury at the bottom of meter, the other is continued by the glass tube to the bottom of well. When no steam is flowing through the pipe the mercury in the well and in the glass tube is level and at zero head. When steam begins to flow its inertia, pressing on the mercury in the well, raises it in the glass tube, proportional to the square of the velocity of the steam, and irrespective of the statical pressure. Behind the glass tube is a revolvable dial graduated circumferentially in pounds pressure, and vertically in pounds avoirdupois for the different heads. To get the rate of flow in pounds per hour, revolve by the hand wheel underneath the meter, the cylindrical dial until the pressure behind the tube corresponds to pressure on the gage, when the top of the mercury will indicate the pounds of steam flowing through per hour.

So far as steam meters are concerned, the third time was a success. Hundreds of successful Pitot steam meters are in operation today, both indicating integrating and recording. This type of meter is used for steam, air or any gas having velocity and pressure, and while the author is not now partaking of the profits, he has some satisfaction in feeling that he had a little something to do in developing a device which has assumed such proportions that it requires a department in the plant of the largest manufacturer of electric apparatus in the world.

No. 729,511.

PATENTED MAY 26, 1903.

C. E. SARGENT.

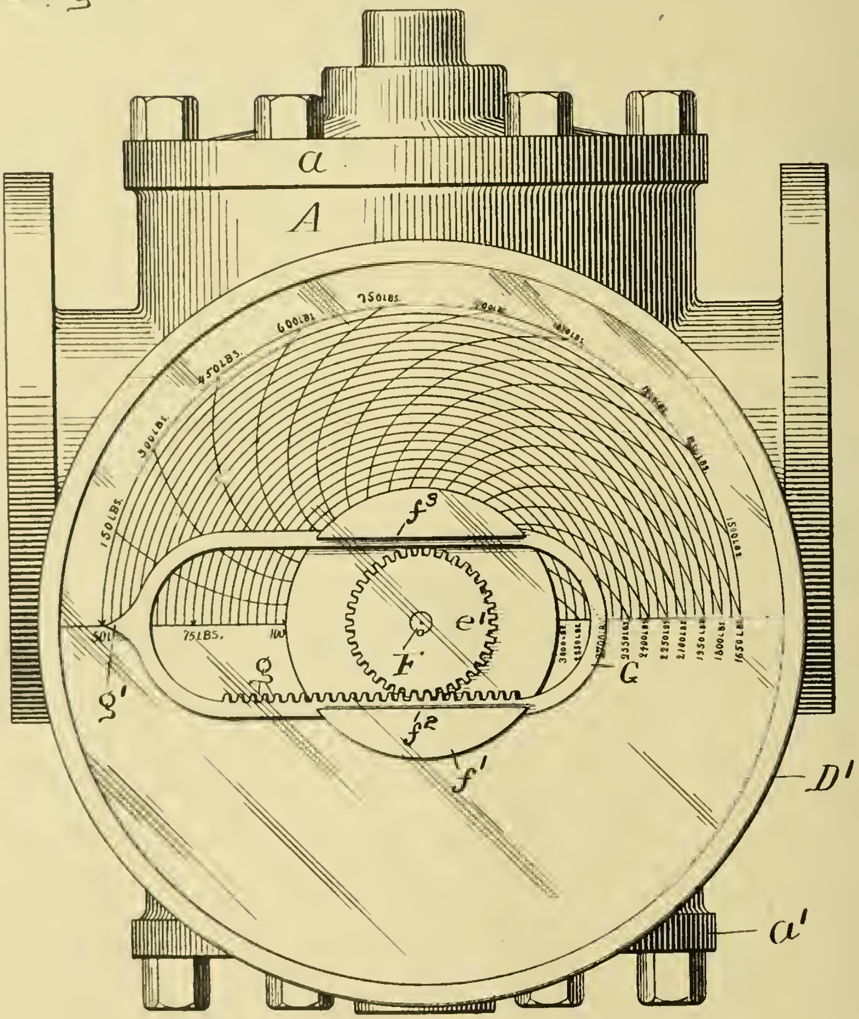
STEAM METER.

APPLICATION FILED MAY 28, 1902.

NO MODEL.

5 SHEETS—SHEET 1.

Fig. 1.



Witnesses:

Chas O. Shervey

S. Bliss

Inventor:

Charles E. Sargent

by H. P. Bitner, Atty.

No. 729,511.

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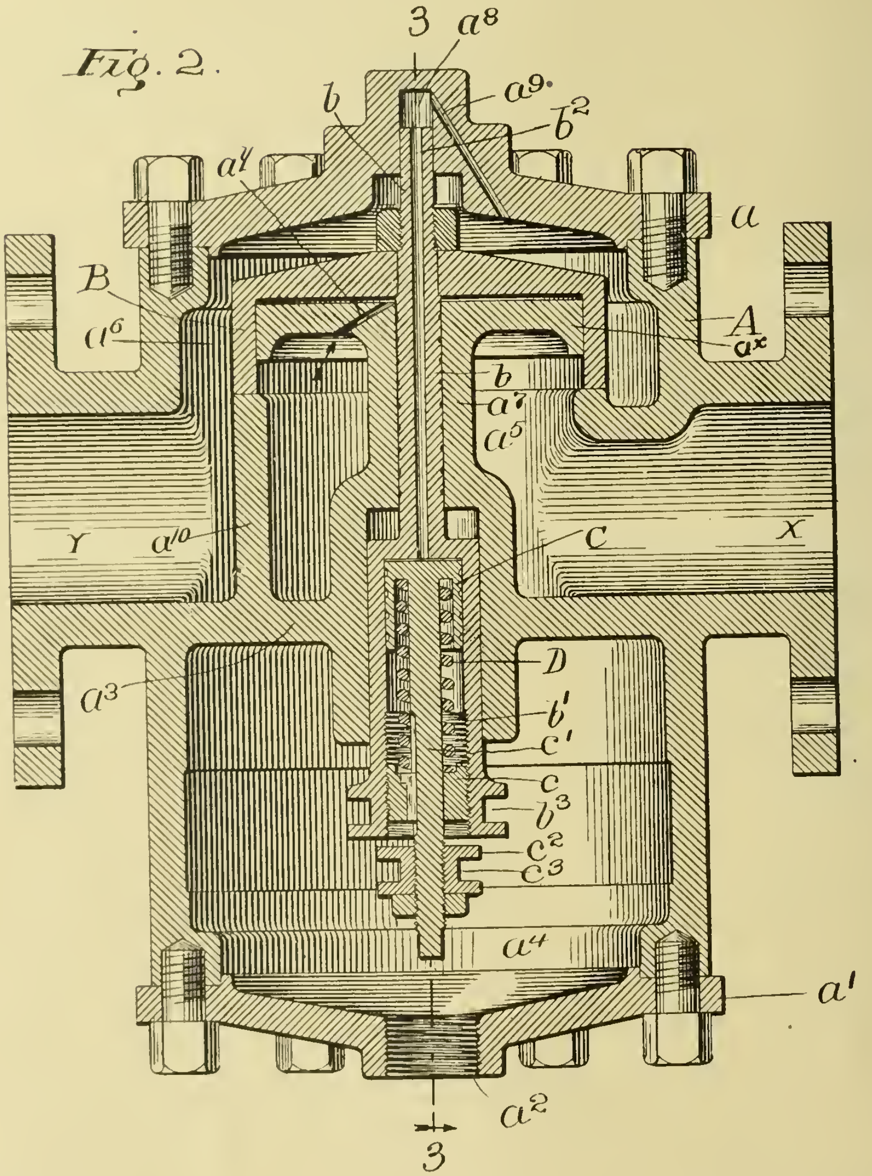
STEAM METER.

APPLICATION FILED MAY 28, 1902.

NO MODEL.

5 SHEETS—SHEET 2.

Fig. 2.



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Atty.

THE NORRIS PETERS CO. PHOTO-LITHO. WASHINGTON, D. C.

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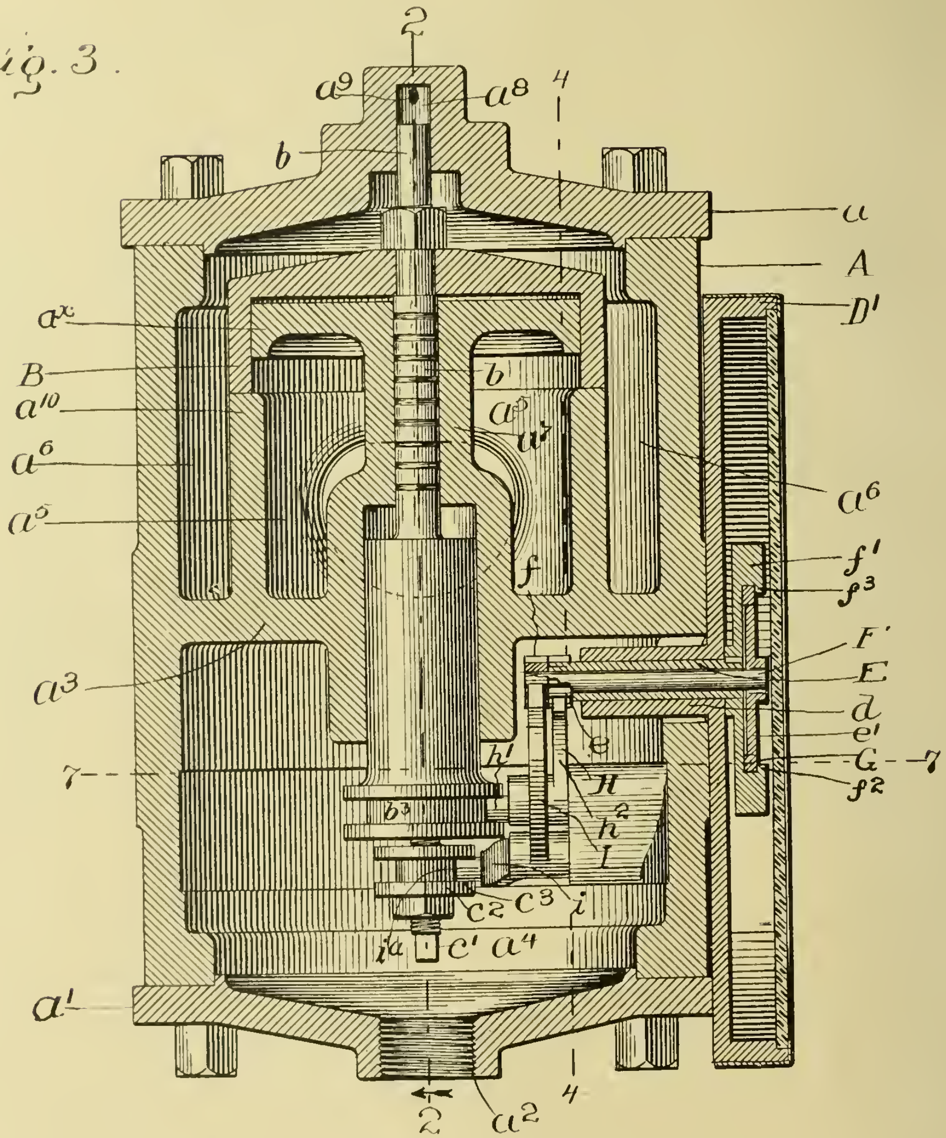
APPLICATION FILED MAY 28, 1902.

NO MODEL.

5 SHEETS—SHEET 3.

Fig. 3.



Witnesses:
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Inventor,
Charles E. Sargent
by H. L. Bitner, Atty.

No. 729,511.

PATENTED MAY 26, 1903.

C. E. SARGENT.

STEAM METER.

APPLICATION FILED MAY 28, 1902.

NO MODEL.

5 SHEETS—SHEET 4.

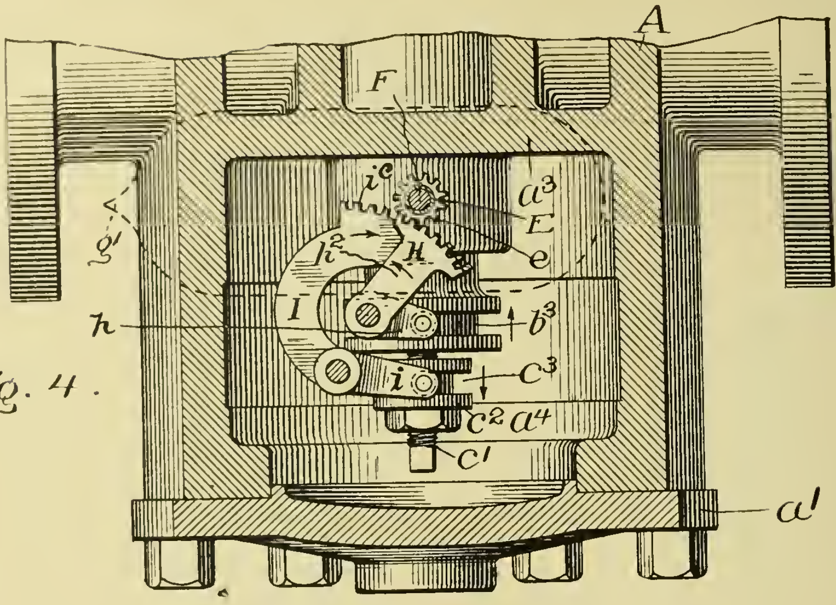

Fig. 4.

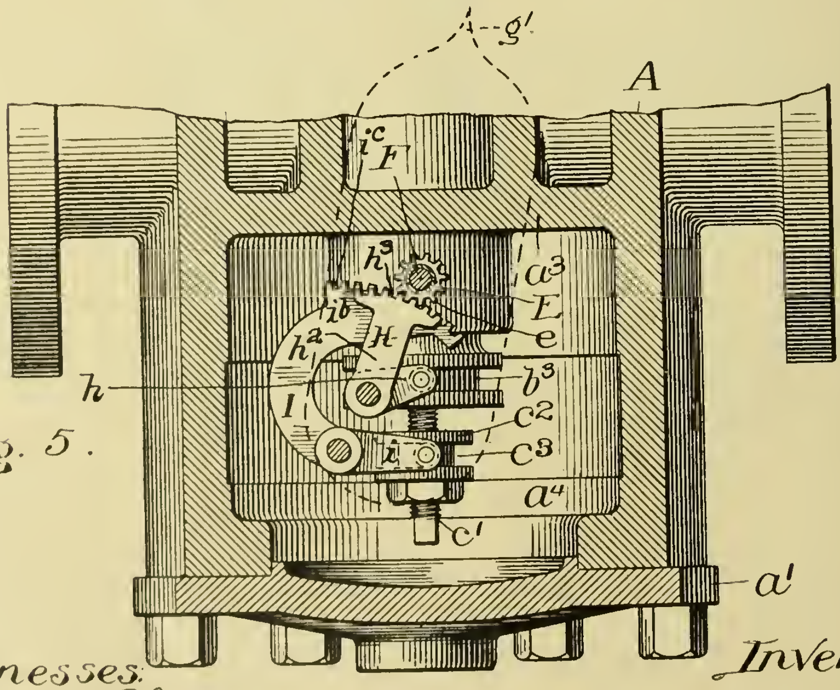

Fig. 5.

Witnesses:
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S. Bliss

Inventor:
Charles E. Sargent
by H. P. Bitner.
Atty.

THE NORRIS PETERS CO. PHOTO-LITHO. WASHINGTON, D.

No. 729,511.

PATENTED MAY 26, 1903.

C. E. SARGENT.

STEAM METER.

APPLICATION FILED MAY 28, 1902.

NO MODEL.

5 SHEETS—SHEET 5.

Fig. 6.

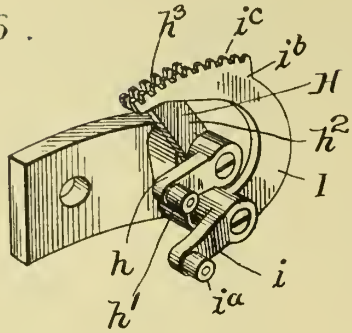
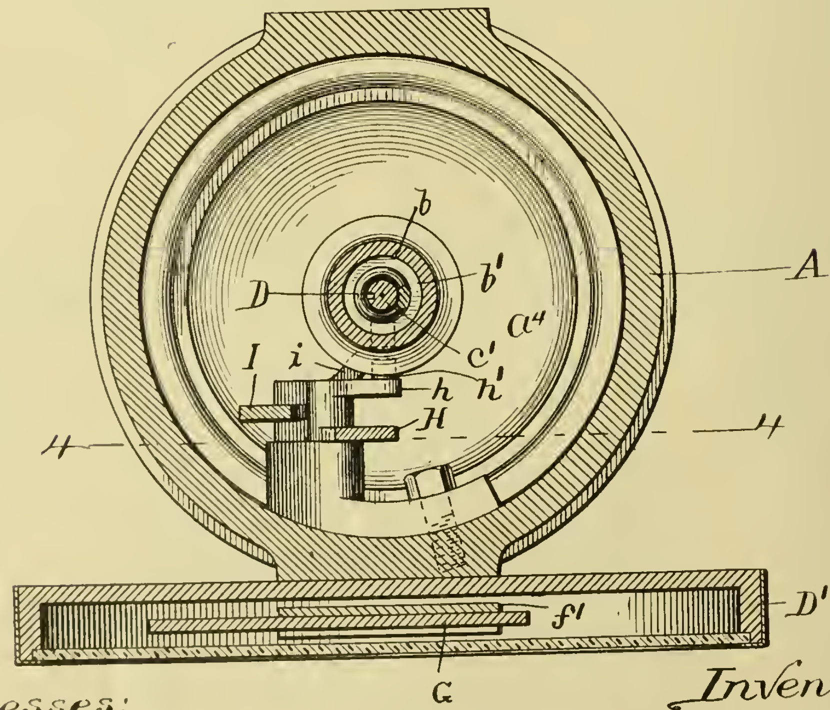


Fig. 7.



Witnesses:
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S. Bliss.

Inventor:
Charles E. Sargent
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No. 729,511. Patented May 26, 1903.

UNITED STATES PATENT OFFICE.

CHARLES E. SARGENT, OF CHICAGO, ILLINOIS, ASSIGNOR OF ONE-HALF TO EDWARD B. ELLICOTT, WILLIAM H. BAKER, AND JOHN I. CONNERY, OF CHICAGO, ILLINOIS.

STEAM-METER.

SPECIFICATION forming part of Letters Patent No. 729,511, dated May 26, 1903.

Application filed May 28, 1902. Serial No. 109,274. (No model.)

To all whom it may concern:

Be it known that I, CHARLES E. SARGENT, a citizen of the United States of America, residing at Chicago, in the county of Cook and State of Illinois, have invented certain new and useful Improvements in Steam-Meters, of which the following is a specification.

My invention relates to certain improvements in steam-meters, the object of which is to provide a device adapted, first, to maintain a predetermined ratio between the pressures upon the opposite sides of the meter; second, to indicate at all times the size of the opening through which the steam or other fluid is passing; third, to indicate at all times the actual steam-pressure upon the discharge side of the meter, and, fourth, preferably to so combine these indicating devices with a suitable dial to indicate graphically the amount of steam in pounds which happens to be passing through the meter at the time it is inspected. In connection with these various purposes it is also my intention to so construct the meter that it may be incapable of disarrangement by the passage of slugs of water through it at the great velocities induced by the passage of a large amount of steam.

To these and other ends my invention consists in certain novel features or characteristics, which are illustrated in the drawings presented herewith, of the preferred form of meter and the essential combinations and relations of the various parts thereof pointed out in the appended claims.

In the drawings, Figure 1 represents a front elevation of my improved meter. Fig. 2 represents a vertical longitudinal section in line 2 2 of Fig. 3. Fig. 3 represents a vertical transverse section in the line 3 3 of Fig. 2. Fig. 4 represents a section on line 4 4 of Fig. 7. Fig. 5 is a similar view showing the indicating apparatus in a different position. Fig. 6 represents a detail perspective of the bell-cranks and racks, and Fig. 7 represents a cross-section on the line 7 7 of Fig. 3.

Referring to the drawings, A is a suitable valve-casing, provided with an upward removable head a and a lower removable head a', the latter being perforated and tapped at a^2, so that it may be connected with a suitable surge tank or sewer. The body of the casing is separated by a horizontal partition a^3 into upper and lower portions, the lower portion a^4 being preferably open through the surge tank or sewer to substantially atmospheric pressure. The upper portion is further divided by a partition a^{10} into a receiving-chamber a^5 and a discharge-chamber a^6. The receiving-chamber a^5 is open at the top, and the opening is covered by a puppet-valve B, seating upon the top of the partition a^{10}. The valve is guided by means of a valve-stem b in a central boss a^7 of the casing. The upper end of the valve-stem enters a pocket a^8 in the head a, said pocket being connected by a port a^9 with the discharge or eduction side a^6 of the meter. The lower part of the central boss a^7 of the casing, as well as the lower portion of the valve-stem b, are enlarged, so that said lower portion of the valve-stem may contain a cylindrical chamber b' of sufficient extent to receive a piston C, fitted to the interior of said chamber and exposed by means of a central longitudinal port b^2 through the upper portion of the valve-stem to whatever pressure enters the pocket a^8 through the port a^9. A nut c in the lower portion of the chamber b' confines a coiled spring D between itself and the piston C, a stem c' extending downward from the piston through the nut and affording a connection with said cylinder. The lower portion of the valve-stem b is provided with a circumferential groove b^3, and a nut c^2 is secured upon the lower end of the piston-stem and contains a similar groove c^3. Upon the front side of the casing is secured a dial-case D', having a central hollow boss d extending into the casing, in which is journaled a sleeve E, and inside of this sleeve is journaled a shaft F. The sleeve E has upon its inner end a pinion e, and the shaft F has upon its inner end a pinion f. Within the lower part of the casing are pivoted two bell-crank levers H I. The lever H has one arm h, upon the end of which is a roller h', running in the groove b^3 on the valve-stem, and a second arm h^2, upon the end of which is a segment h^3 in mesh with the pinion e. The lever I has an arm i, upon the end of which is a roller i^a, running in the groove c^3 of the nut c^2, and a second arm i^b, upon the end of which is a segment i^c in mesh with the pinion f. Through these connections the vertical movement of the valve-stem imparts a rotary movement to the sleeve E, and a vertical movement of the piston-stem imparts a rotary movement to the shaft F. On the outer end of the sleeve is secured a disk f', diametrically channeled on its outer face to receive a radial sliding pointer G, the channel being undercut upon the opposite sides to form overhanging flanges f^2 f^3, which secure the pointer in place upon the face of the disk. The pointer itself is preferably made in the form of an open frame, upon the lower inner side of which is a rack g in mesh with a gear e', secured to the outer end of the shaft F. By this connection it will be seen that the rotary movement of said shaft relative to the sleeve imparts a radial movement to the pointer, while the rotary movement of the sleeve and shaft together moves the pointer angularly about the common center of the sleeve and shaft. A pointed end g' is provided on the pointer, from which the reading is to be taken. The face of the dial is ruled with concentric circles, and one of the diameters is graduated to enable the radial position of the pointer to be read regardless of its angular position upon the dial, a series of curves reaching from the inner to the outer circle are provided, and the outer circle is graduated to show the weight of steam per hour, indicated when the pointed end of the pointer stands at any point along the particular curve to which a given mark is affixed.

The induction or receiving chamber of the casing is provided with an induction-port X and the eduction or discharge chamber with an eduction-port Y, the port X being connected with the receiving steam-pipes and the port Y with the pipe leading to the engine or other point of use of the steam. The puppet-valve B is made in the form of an inverted cup, and the central boss a^7 is enlarged at the top into a disk a^x, fitted to the interior of the piston. A small port a^y extends through this disk and connects the induction-chamber with the space between the top of the disk-shaped head and the valve B.

Starting with the casing empty, the valve will be found normally in the closed position because of its own gravity. If steam be turned into the induction-chamber, it will pass through the small port a^y and raise the valve, carrying with it the piston inside of the valve-stem and imparting to the pointer an angular movement proportional to the extent of the opening. As soon as the valve is open the steam will rush into the eduction-chamber and from there will pass through the port a^9 into the pocket a^8 and down through the valve-stem until its pressure is exerted upon the piston C within said valve-stem. This pressure will push the piston downward to an extent dependent upon the degree of pressure, and the downward movement of the piston will impart a radial movement of the pointer, whatever its angular position proportional to the pressure of steam in the eduction-chamber of the casing—that is to say, the pointed end of the pointer will be drawn inward toward the center of the circle, following the horse-power curves, and the reading in pounds of steam passing through will be constant, irrespective of the pressure of the steam. As soon as the pressure upon the eduction side rises to a point slightly short of that on the induction side the excess of area on the eduction side of the valve afforded by the upper end of the valve-stem will cause the steam-pressure upon said eduction side to tend to close the valve and hold it in that position until the use of the steam upon the eduction side lowers the pressure on that side sufficiently to enable the inflowing steam to raise the valve and allow more steam to pass through. The ratio of the area to which pressure is applied upon the eduction side of the valve to the area under pressure on the induction side is constant. Therefore the difference in pressures between the two sides of the meter will increase as the absolute pressure increases.

It is a well-known law of steam and gases that the greater the difference in pressure between two sides of a definite opening the greater the weight which will flow through and also the greater the absolute pressure and density, the difference being constant the greater the weight of steam which will flow through a definite opening.

Now in the device herein described a constant ratio will be maintained between the induction and eduction sides. Therefore there will be an increasing difference in pressure as the absolute pressure increases, while at the same time the opening through which the steam flows will diminish, so that while the angular position of the pointer is less the radial position is greater, and the steam going through must be constant, as the end of the pointer indicates.

The device above described is constructed in the form preferred at the present time; but it is realized that great variation is possible in the parts and in their relative arrangement, and for that reason the invention is not limited to the specific construction illustrated and described.

I claim as new and desire to secure by Letters Patent—

1. In a fluid-meter, the combination with a suitable casing having a passage through it for the fluid, of a valve governing the size of said passage, a pressure-actuated device moving with said valve when the opening is changed and having an independent movement caused by variation in the pressure of the fluid, a suitable indicating device and connections between said indicating device and the valve and pressure-actuated devices, respectively, whereby said indicating device affords an indication dependent both upon

the size of the opening and the pressure of the fluid passing therethrough, substantially as described.

2. In a fluid-meter, the combination with a casing having an opening through it for the fluid, and a valve controlling said opening, of a pressure-actuated device mounted on the valve and moving therewith and having independent movement with respect thereto, governed by the pressure within the valve and an indicating device connected to the valve and moving therewith and having a movement effected thereby independent of and in addition to that caused by the valve itself, substantially as described.

3. In a steam-meter, the combination with a single pointer, of suitable devices for indicating volume and pressure, said pointer being so geared to said indicating devices as to indicate, by its position, the weight of steam passing through said meter, substantially as described.

4. In a steam-meter, the combination of a device for producing a variable opening and adapted to keep a constant ratio between the pressures on the two sides of said opening regardless of absolute pressure, with a pointer actuated by said device and adapted to indicate the size of said opening, substantially as described.

5. In a steam-meter, the combination of a valve adapted to produce a variable opening, and preserve a constant ratio between the pressures on the two sides of said opening regardless of absolute pressure, of a needle so geared to said valve as to indicate the volume of steam passing through said opening, substantially as described.

6. In a steam-meter, the combination with a valve controlling the size of a variable opening and adapted to preserve a constant ratio between the pressures upon the two sides of said opening regardless of absolute pressure, a valve-stem attached to said valve and adapted to hold it in place, said valve-stem opening at its lower extremity to the atmosphere, of a pointer so geared to the lower end of said valve-stem as to indicate by its position, the volume of steam passing through said variable opening, substantially as described.

7. In a steam-meter, the combination with a valve governing the size of a variable opening, said valve having steam-pressure upon its upper and lower surfaces, said surfaces being so proportioned that said valve will maintain a constant ratio between the pressures upon the two sides of said variable opening regardless of absolute pressure, and a valve-stem opening to the atmosphere, of a pointer so geared to said valve-stem as to indicate the volume of steam passing through said variable opening, substantially as described.

8. In a steam-meter, the combination with a frame perforated for the passage of steam, of a valve closing said perforation, a valve-stem guided in a suitable perforation in said frame, said frame having two other perforations, one extending from the inlet side of said valve to its under side and one extending from the outlet side of said valve, to the upper part of said valve-stem, the areas of the lower surface of said valve and the upper surface of said valve-stem being so proportioned as to preserve a constant ratio between the pressures on the opposite sides of said meter, substantially as described.

9. In a steam-meter, the combination with a frame perforated for the passage of steam, of a valve adapted to maintain a constant ratio between the pressures on opposite sides of said perforation, a valve-stem guided in a perforation in said frame, a pressure-gage adapted to be actuated by the pressure in said meter, a suitable pointer and means of connection between said pointer and said valve and pressure-gage, whereby said pointer indicates the weight of steam passing through the meter, substantially as described.

10. In a steam-meter, the combination with a frame perforated for the passage of steam, of a valve adapted to preserve a constant ratio between the pressures upon the two sides of said perforation, a valve-stem enlarged at its lower end, connected with said valve and guided by a perforation in said frame, of a piston and compression-spring within the enlarged end of said valve-stem and a pointer so actuated by said valve-stem and said piston and spring as to indicate the weight of steam passing through said meter, substantially as described.

11. In a steam-meter, the combination with a valve-stem adapted to indicate the size of a variable steam-passage and a piston confined within said valve-stem adapted to indicate the absolute pressure, of a needle, G, provided with a rack, g, a pinion, e', in engagement with said rack, means of connection between said pinion and said piston and means of connection between said needle and said valve-stem, whereby said needle is moved angularly by the motions of said valve-stem and radially by the motions of said piston, substantially as described.

12. In a steam-meter the combination with a volume-indicating valve-stem and a pressure-indicating piston confined within said valve-stem, of a pointer-frame, G, a sleeve connected therewith, a pinion, e, upon said sleeve, a bell-crank, H, a rack, h^3, upon said bell-crank, engaging the pinion, e, a roller upon said bell-crank engaged by said volume-indicating valve-stem, said pointer-frame being thereby adapted to be angularly rotated by the motion of said volume-indicating valve-stem and a needle proper adapted to move radially with said pointer-frame, G, provided with a rack, g, a pinion, e', engaging said rack, the shaft, F, running through the sleeve, E, connected with said pinion, the pinion, f, upon the other end of said shaft, a bell-crank, I, a rack, i^c, upon one end thereof,

connecting the pinion, *j*, a roller, i^3, connected with said bell-crank and engaged by said pressure-indicating piston, said pointer being thereby adapted to be moved radially by the motion of said pressure-indicating piston, substantially as described.

13. In a meter adapted to measure a fluid of variable pressure, the combination with a suitably-mounted indicating device capable of two independent movements in different directions, of a fluid-actuated device, the movement of which is governed by the pressure of the fluid within the meter, a second fluid-actuated device, the movement of which is proportionate to the volume of the fluid which passes through the meter, and suitable connecting devices between said fluid-actuated devices and said indicating device, whereby their respective movements may impart corresponding movements to the pointer in said two independent directions, substantially as described.

14. In a device of the class described, the combination with a pointer adapted to move radially with changes in pressure and angularly with changes in volume of the steam passing through the said device, of a dial provided with intersecting curves, whereby the position of said pointer may be read directly in weight of steam, substantially as set forth.

In witness whereof I have hereunto set my hand, at Chicago, in the county of Cook and State of Illinois, this 28th day of April, A. D. 1902.

CHARLES E. SARGENT.

Witnesses:
CHARLES O. SHERVEY,
S. BLISS.

No. 883,670. PATENTED MAR. 31, 1908.

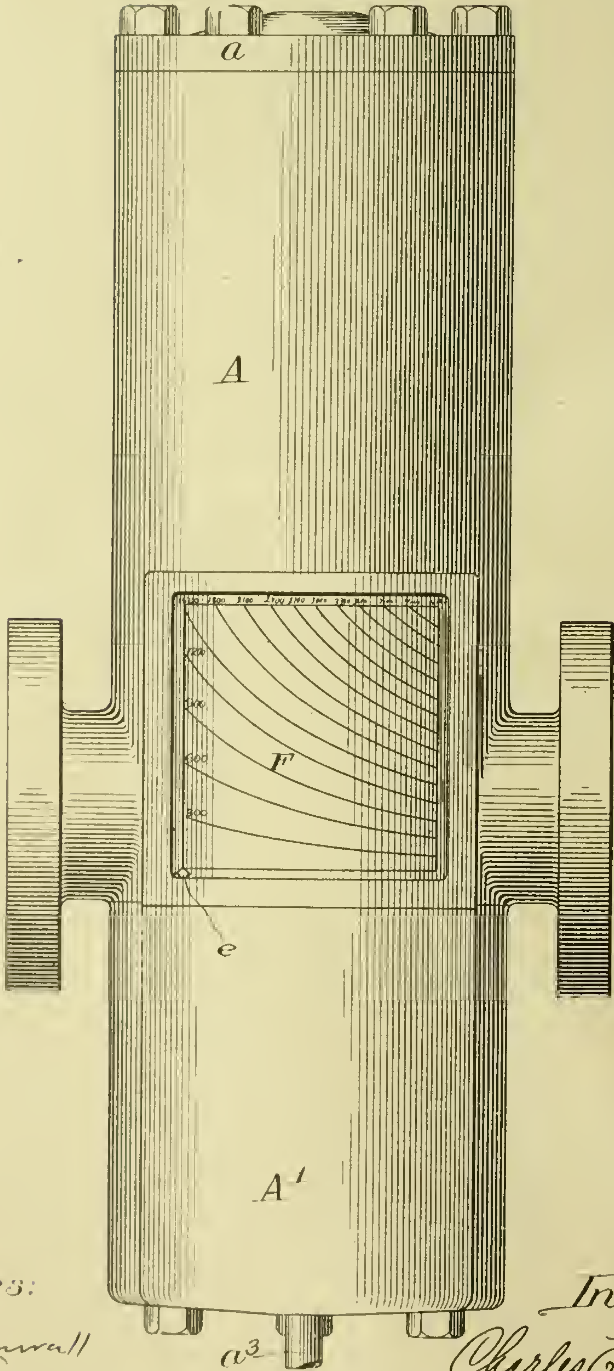
C. E. SARGENT.

STEAM METER.

APPLICATION FILED MAY 6, 1905.

5 SHEETS—SHEET 1.

Fig. 1.



Witnesses:

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J. E. Sherrey.

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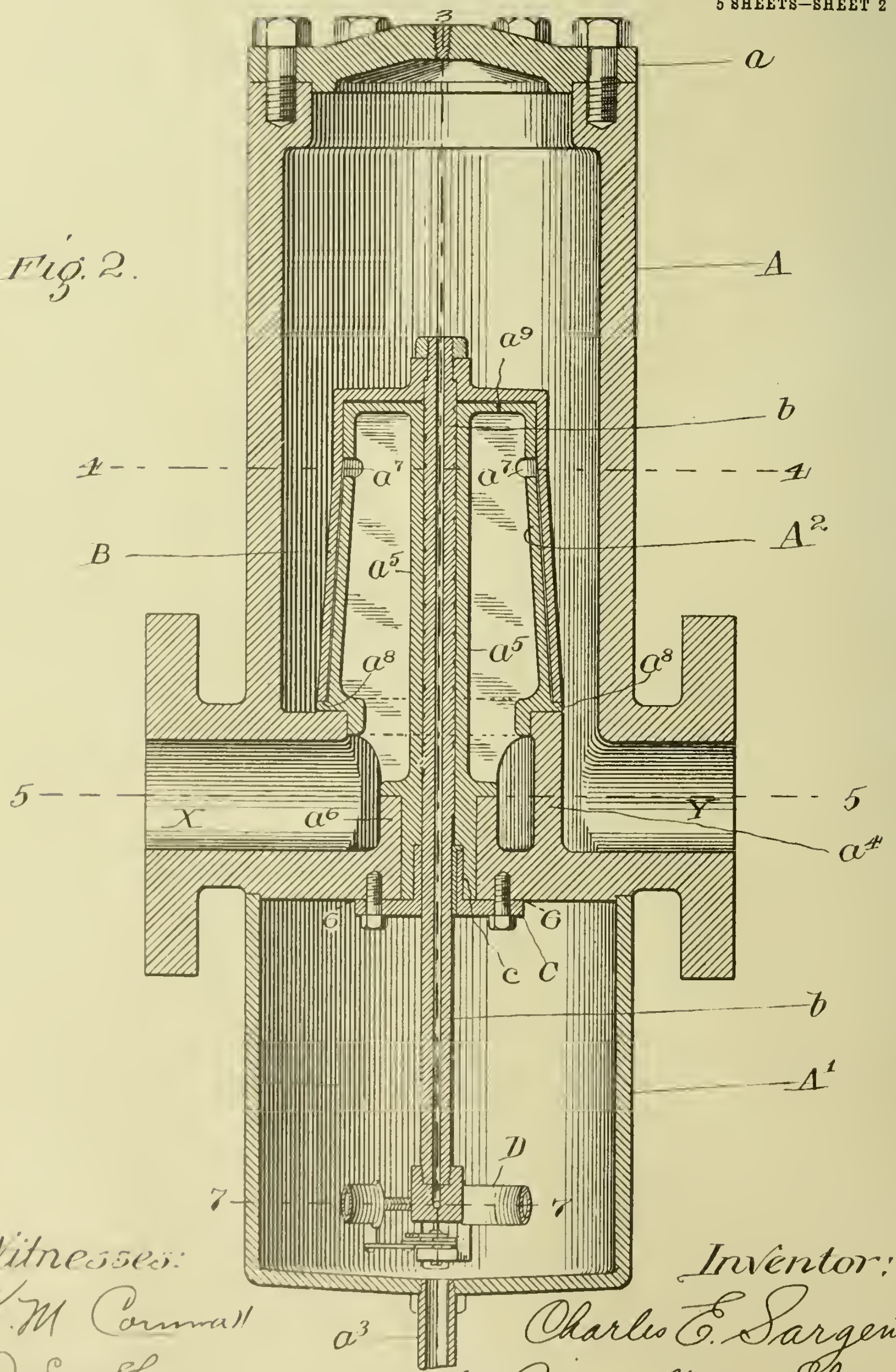
5 SHEETS—SHEET 2

Fig. 2.



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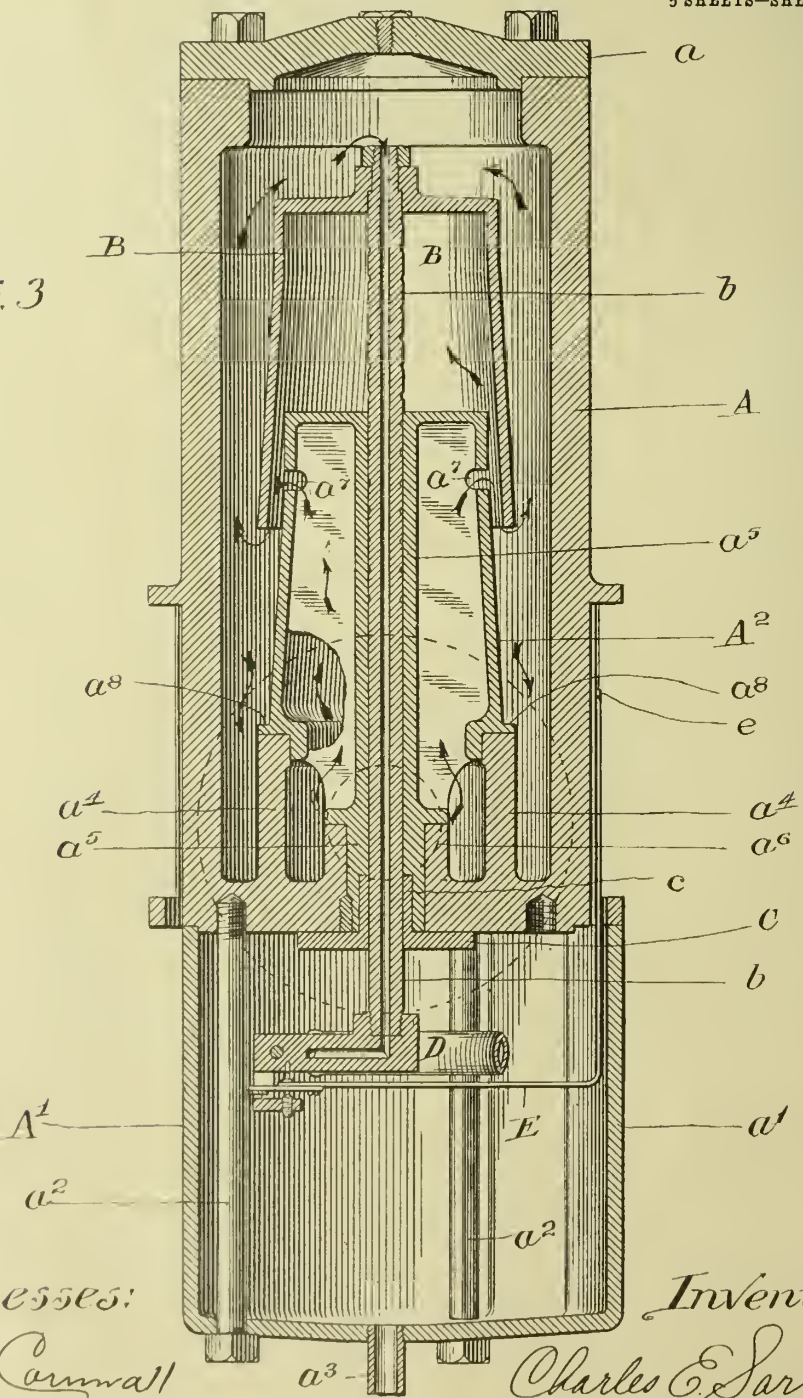
5 SHEETS—SHEET 3.

Fig. 3



Witnesses:

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STEAM METER.

APPLICATION FILED MAY 6, 1905.

6 SHEETS—SHEET 4.

Fig. 4.

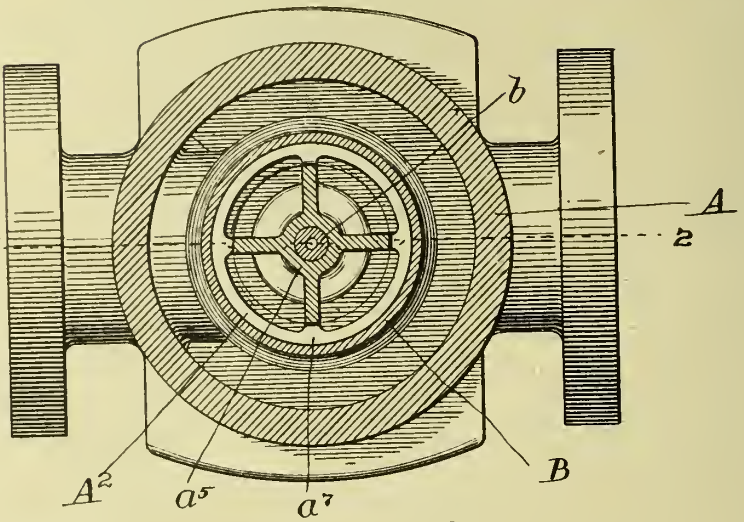


Fig. 5.

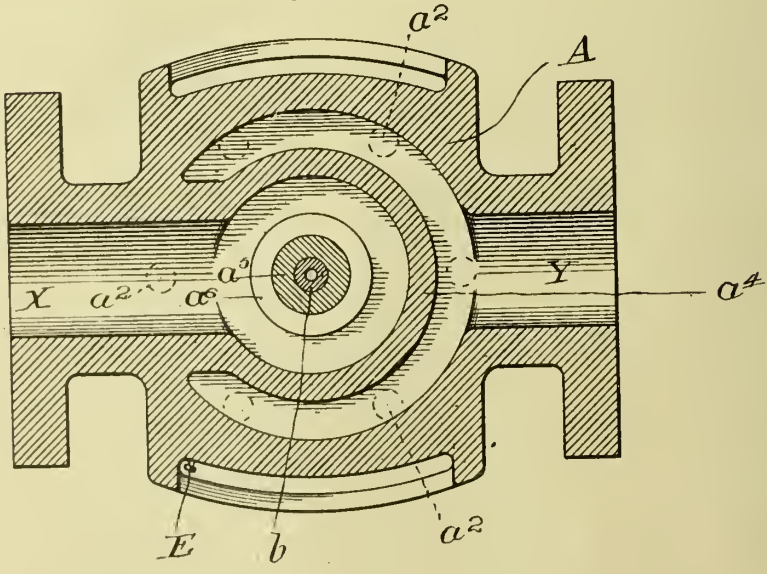
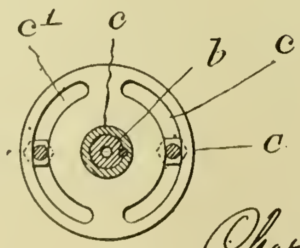


Fig. 6.



Witnesses:
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No. 883,670. PATENTED MAR. 31, 1908.

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STEAM METER.

APPLICATION FILED MAY 6, 1905.

5 SHEETS—SHEET 5.

Fig. 7.

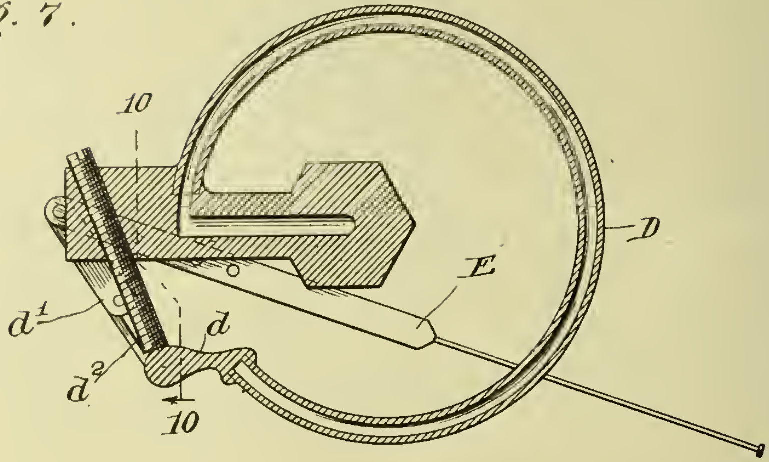


Fig. 8.

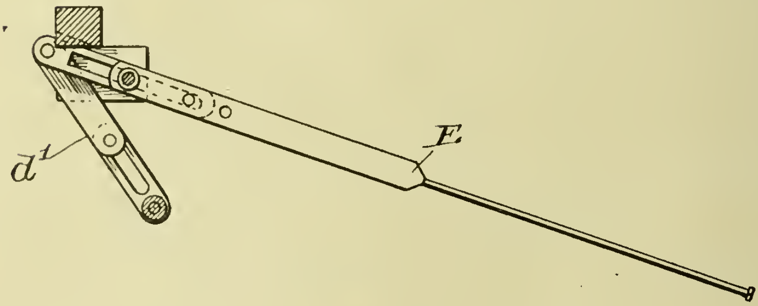


Fig. 9

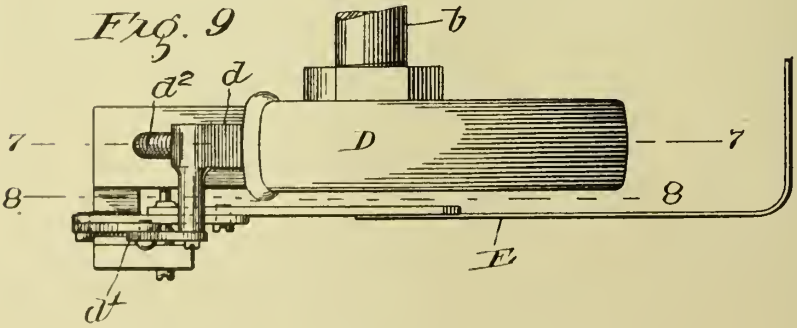
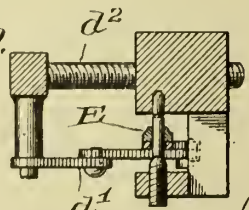


Fig. 10.



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UNITED STATES PATENT OFFICE.

CHARLES E. SARGENT, OF CHICAGO, ILLINOIS.

STEAM-METER.

No. 883,670. Specification of Letters Patent. Patented March 31, 1908.

Application filed May 6, 1905. Serial No. 259,083.

To all whom it may concern:

Be it known that I, CHARLES E. SARGENT, a citizen of the United States of America, residing at Chicago, in the county of Cook and State of Illinois, have invented certain new and useful Improvements in Steam-Meters, of which the following is a specification.

My invention relates to improvements in steam meters and is fully described and explained in this specification, and shown in the accompanying drawings, in which

Figure 1 is an elevation of my improved device; Fig. 2 is a central longitudinal section on line 2—2 of Fig. 4 showing the device in the position it occupies when no steam is passing through it; Fig. 3 is a section in the line 3—3 of Fig. 2, showing the parts in the position which they occupy when steam is passing through the meter; Fig. 4 is a section in the line 4—4 of Fig. 2; Fig. 5 is a section in the line 5—5 of Fig. 2; Fig. 6 is a section in the line 6—6 of Fig. 2; Fig. 7 is a section in the line 7—7 of Fig. 2 on an enlarged scale; Fig. 8 is a horizontal section in the line 8—8 of Fig. 9; Fig. 9 is an elevation of the pressure-indicating-portion of the device looking in the same direction as in Fig. 3, and Fig. 10 is a section in the line 10—10 of Fig. 7.

My present device is intended as an improvement over a similar device shown in my Patent No. 729,511, dated May 26, 1903. In the device of said patent the construction is such that the poppet valve rises but a short distance in all, and as a result, it is necessary to use, instead of a simple direct connection between the puppet valve and the needle, a multiplying device which will give the needle a considerable amplitude of movement. Furthermore, the pressure-indicating device has but small total movement and it is, therefore, necessary to multiply its movement.

My present invention consists in substituting for the puppet valve of my prior patent a puppet valve so constructed as to move through a long space and to combine with it a sensitive pressure-indicating device so that all multiplying means are dispensed with.

Referring to the drawings, A, is a suitable valve casing provided with an upper removable head, *a*. Below the casing, A, and secured thereto is a cup, A^1, which is cylindrical in form, but which has a forward projection, a^1. The cup is secured to the casing, A, by bolts, a^2, here shown as three in number and six corresponding holes are provided in the casing to receive the ends of the bolts so that the cup can be turned around for a purpose which will hereafter appear. The cup, A^1, is provided with a small outlet pipe, a^3, which communicates with a surge tank or sewer.

The casing, A, is provided with a partially cylindrical partition, a^4, inclosing a chamber into which opens an induction port, X, and secured to the top of this partition, a^4, is a frusto-conical, hollow, downwardly-open cup, A^2, provided with a central hollow boss, a^5, secured to a corresponding boss, a^6, in the bottom of the valve-casing, A. The hollow frustro-conical cup, A^2, communicates with the space inside the partition, a^4, and this cup and partition divides the valve-casing into induction and eduction chambers, the induction chamber being that space within said cup and wall, and the eduction chamber being that space within the casing and outside the same. An eduction port, Y, communicates with the eduction chamber. The eduction and induction chambers are connected by a horizontal slot, a^7, near the top of the frusto-conical cup, A^2. A frusto-conical valve, B, fits over the frusto-conical cup, A^2, and seats on a shoulder, a^8, at the lower edge of said cup. A perforation, a^9, at the top of the frusto-conical cup, A^2, admits pressure to the end of the valve, B. A hollow valve stem, *b*, extends through the boss, a^5, guiding the valve, and said stem is keyed against rotation in a boss, *c*, projecting upwards from a plate, C, secured to the bottom of the valve casing, A. This plate, C, is best seen in Fig. 6, and it will be noted that it is provided with slots, c^1, through which the attaching screws extend, whereby it may be angularly adjusted.

Secured to the lower end of the hollow valve stem, *b*, is a Bourdon spring, D, the curve of which lies in a horizontal plane and the hollow of which communicates with the hollow of the valve stem, so that pressure from the top of the valve, B, will be transmitted to said spring. The free end, *d*, of the Bourdon spring is connected by an adjustable link, d^1, to one end of a needle, E, pivoted between its ends. Movement of the spring is limited in one direction by an adjustable screw or stop, d^2. It will be seen that an increase of pressure in the meter will straighten the Bourdon spring and will consequently move the point of the needle upwards as seen in Figs. 7 and 8, or to the right in the machine as set up. The needle, E, is carried upwards in the forward projection, a^1, of the cup, A^1, the said needle terminating in an indicating point, *e*, which when the device is not subject to pressure, stands just above the lower edge of the casing and in front of a dial, F, on the front of the casing, A.

The operation of my improved device is substantially as follows: Starting with the parts as shown in Fig. 2, if vapor under pressure is introduced at the induction port, X, it will pass up through the frusto-conical cup, A^2, and reach the lower surface of the valve, B, which it will raise. As the valve rises, pressure on the eduction side thereof will increase and the valve will finally cease to rise when the pressure on the two sides becomes equal. When this point is reached it will be found that the absolute pressure in the induction chamber is greater than that in the eduction chamber, because the area of the valve exposed to pressure in the induction chamber is less than the area of the valve exposed to pressure in the eduction chamber. In other words, a given pressure in the eduction chamber will balance a slightly greater pressure in the induction chamber. As the valve areas exposed in the two chambers bear a constant relation to each other, the absolute difference in pressure on the two sides of the valve will constantly vary for various absolute pressures, but the ratio between the pressures on the opposite sides will be constant. It is a well known law of gases, that the greater the difference in the pressure between the two sides of a given opening, the greater the weight of gas which will pass through, or to put the matter in another way, if the absolute pressure is kept constant on one side, the greater the difference in pressure between the two sides of the opening, the greater the volume which will pass through. This is substantially what is indicated by vertical rise of the valve of my improved device. If the absolute pressure on the eduction side of the device be kept constant and still the valve rises this means that a greater volume of gas or steam is passing through. Owing to the peculiar form of the valve of my improved device, the valve is not fully opened until a very considerable vertical movement has taken place, and as a result, a scale can properly be drawn which will show the volume passing through by direct reading from the valve without the interposition of any movement-multiplying device. It will be seen that as the valve rises, the needle moves upward at the same speed so that when the valve reaches the top limit of its movement the indicating point on the needle has reached the top of the dial.

To indicate weight of steam it is necessary not only to consider volume, but absolute pressure, and this is taken care of by the Bourdon spring which is in direct connection through the hollow valve stem with the eduction chamber. It will be evident that if the valve remains stationary, *i. e.* if the volume remains constant and the absolute pressure increases, the weight will increase. The Bourdon spring is so sensitive that its movements can be read directly on the dial. As the pressure increases the indicating point on the needle swings to the right so that at any moment the position of the indicating point shows the speed with which steam is passing through by weight. The dial is made to read in the number of pounds per hour which is passing through.

Meters of this class are in practice set up in the steam supply pipes of engines or other steam using devices, and the eduction ports must be next the engine. In engine rooms and the like it is frequently the case that the steam pipes run close to the wall so that only one side of the device is visible when set up in this manner. To avoid the necessity of making right and left hand meters the casing, A, is provided with an extra dial at its rear side, so that the meter can be reversed. This is done by removing the cup, A^1, and releasing the plate, C, from engagement with the casing, A. The valve stem and plate, C, can then be turned around so as to bring the needle on the opposite side of the device, after which the plate, C, can be placed in position and the needle adjusted by turning said plate slightly upon its supporting screws. The cup, A^1, is then replaced in reversed position so that the projection, a^1, is on the opposite side of the device.

I realize that considerable variation is possible in the details of the construction without departing from the spirit of the invention, and I therefore do not intend to limit myself to the specific form herein shown and described.

I claim as new and desire to secure by Letters Patent:—

1. The combination with a casing, of a frusto-conical partition within the same, a passage for the entrance of vapor beneath said frusto-conical partition, a frusto-conical valve seating over said partition and inclosing perforations therein, a device capable of being effected by pressure carried by said valve and having communication with the space within said casing, and an indicator operated by said device.

2. The combination with a casing having inlet and outlet openings, of a frusto-conical partition beneath which the inlet opening enters and between the same and the exhaust opening, a frusto-conical valve seating over said frusto-conical partition and inclosing perforations therein, a hollow valve stem carried by said valve and communicating with the vapor in said casing, and indi-

cating mechanism communicating with the hollow in said valve stem and carried by said valve stem, said indicating mechanism being constructed and arranged to perform an indicating movement with certain of its parts under the influence of pressure, whereby said indicating mechanism is moved bodily as the valve rises and performs a second movement independent of its bodily movement as the pressure varies.

3. The combination with a frame having inlet and outlet openings, of a frusto-conical partition beneath which the inlet opening enters and between the same and the exhaust opening, a frusto-conical valve seating over said frusto-conical partition and inclosing perforations therein, said frusto-conical partition having an opening in its top whereby vapor reaches the lower surface of said frusto-conical valve, a pressure-actuated indicating device, operative connections between said indicating device and said valve whereby said indicating device moves bodily with the valve, said pressure-indicating device having communication through a perforation in said operative connections with the vapor within said casing.

4. The combination with a casing having an opening therethrough, of a valve controlling said opening and constructed and arranged to maintain a constant ratio between the pressures upon its two sides, said valve being also constructed and arranged to rise more rapidly than it increases any single dimension of said opening, a Bourdon spring carried by the valve, connections between the Bourdon spring and the interior of the casing, and a needle carried by the valve and actuated by the Bourdon spring.

5. In a device of the class described, the combination with a frame having induction and eduction ports, a valve arranged to control a passage-way through said frame and a valve stem, of a pressure-indicating device carried by the valve stem, a needle carried by the valve stem and actuated by the pressure-indicating device, a cup secured to the bottom of the frame and having a forward projection to receive the needle, two dials on opposite sides of the frame and means for securing the cup in two diametrically opposite positions and guiding the valve stem in positions diametrically opposite.

In witness whereof I have signed the above application for Letters Patent at Chicago, in the county of Cook and State of Illinois, this 28th day of April, A. D. 1905.

CHARLES E. SARGENT.

Witnesses:
CHAS. O. SHERVEY,
J. E. SHERVEY.

No. 886,255.

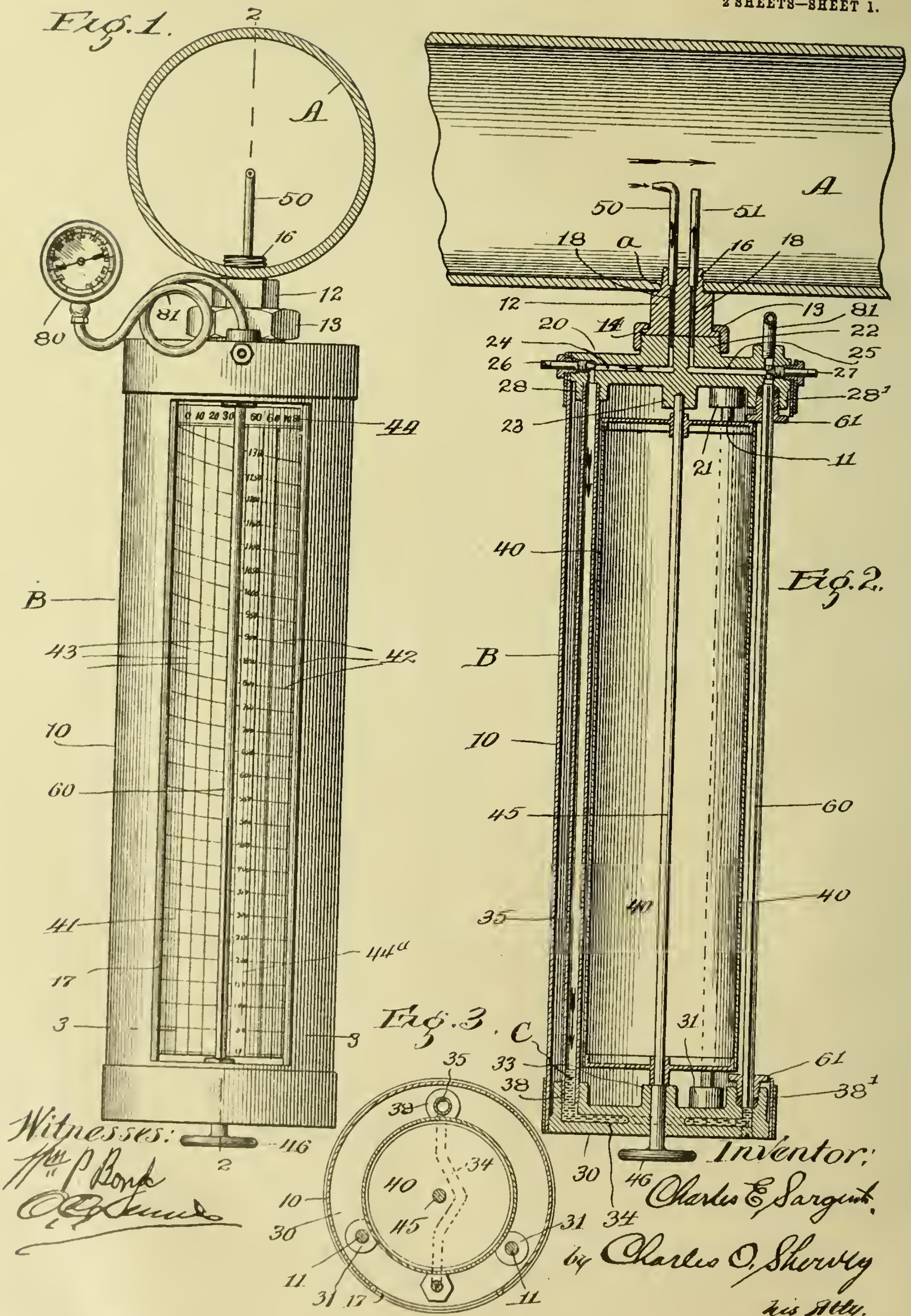
PATENTED APR. 28, 1908.

C. E. SARGENT.

STEAM METER.

APPLICATION FILED JAN. 28, 1907.

2 SHEETS—SHEET 1.



Witnesses:

Inventor:
Charles E. Sargent.
by Charles O. Shervey
his Atty.

THE NORRIS PETERS CO., WASHINGTON, D. C.

No. 886,255. PATENTED APR. 28, 1908.

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STEAM METER.

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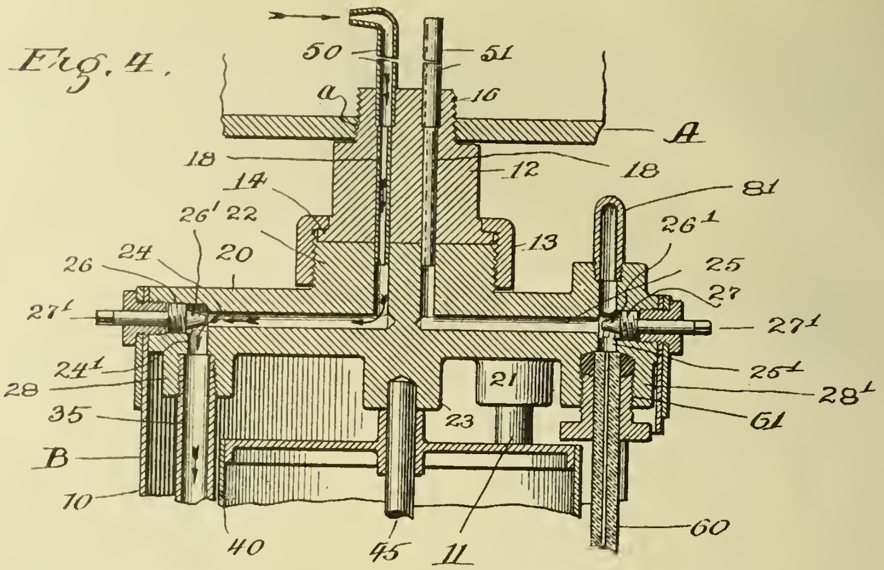
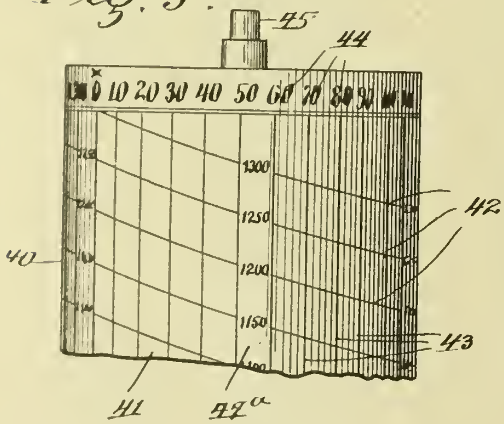
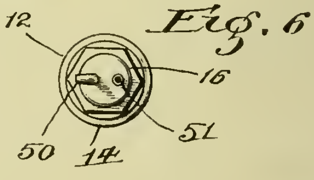
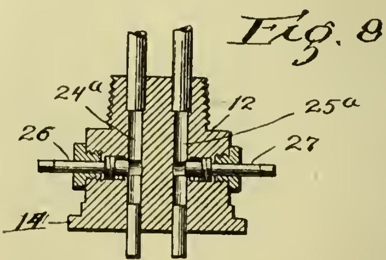
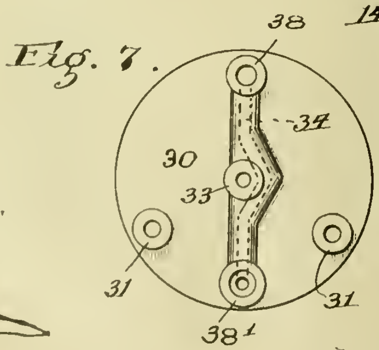










Witnesses:
Wm. P. Bond

Inventor:
Charles E. Sargent
by Charles O. Sherwy
his Atty

THE NORRIS PETERS CO., WASHINGTON, D. C.

UNITED STATES PATENT OFFICE.

CHARLES E. SARGENT, OF CHICAGO, ILLINOIS, ASSIGNOR TO SARGENT STEAM METER COMPANY, OF CHICAGO, ILLINOIS, A CORPORATION OF ILLINOIS.

STEAM-METER.

No. 886,255. Specification of Letters Patent. Patented April 28, 1908.

Application filed January 28, 1907. Serial No. 354,410.

To all whom it may concern:

Be it known that I, CHARLES E. SARGENT, a citizen of the United States, residing in the city of Chicago, in the county of Cook and State of Illinois, have invented certain new and useful Improvements in Steam-Meters, of which the following is a full, clear, and exact description.

My invention relates to certain new and useful improvements in meters, the object being to provide a simple, efficient and practical meter for indicating at all times, the weight of steam passing through a given pipe.

Another object is to produce a meter which may be readily attached to a steam pipe or the like, without the necessity of disconnecting the pipe.

Another object is to provide, in a meter of this class, mechanism for indicating the weight of steam per hour or any other given period of time, passing through the pipe regardless of the pressure in the same.

Other objects and advantages will appear in the course of this specification and the essential features will be more definitely pointed out in claims appended hereto.

The invention is clearly illustrated in the drawings furnished herewith in which

Figure 1 is a front view of a meter embodying my invention and showing the same attached to a steam pipe. Fig. 2 is a central, vertical section taken on the line 2—2, Fig. 1. Fig. 3 is a horizontal section taken on the line 3—3, Fig. 1. Fig. 4 is an enlarged sectional view of the upper portion of the device. Fig. 5 is a fragmental side view of the indicating dial. Fig. 6 is a plan view of a connecting plug. Fig. 7 is a plan view of the bottom head of the device and Fig. 8 is a sectional view of a modification.

Referring to these drawings, A represents a pipe through which steam or other fluid is conducted from any suitable source of supply, to the engines, pumps, or other apparatus with which it is desired to supply steam or other fluid under pressure.

B represents the meter, which as shown is cylindrical in form and depends from the steam pipe A.

The casing of the meter comprises a shell 10, top and bottom heads 20—30, and connecting rods 11. The ends of the shell surround the heads, and the rods 11 are threaded in bosses 21, 31, formed on the opposing faces of the heads. The upper head contains an upwardly extending screw threaded nipple 22, which is secured to a connecting plug 12, by a nut 13, which is threaded upon nipple 22. The plug 12, contains an annular flange 14, upon its lower end which is engaged by an inwardly extending flange on the nut 13, to clamp the plug 12 in place upon the nipple 22. The upper end of the plug 12 is reduced in diameter to form a nipple 16, which is screw threaded and is screwed into a tapped opening *a*, which is provided in the steam pipe for its connection with the meter.

Within the casing is journaled a rotatable cylinder 40, covered by a dial 41. This dial is made up of vertical equidistant parallel "pressure" lines 43, and intersecting curved lines 42, which cross the vertical lines at practically equidistant points. The pressure represented by each vertical line is noted at 44, around the upper part of the dial. In vertical spaces around the cylinder and sufficiently close so that one space is always in sight are noted as at 44^a, the weights in pounds, represented by the circumferentially inclined curves 42. The cylinder 40 is mounted upon a shaft 45, which is journaled in bosses 23, 33, on the heads 20, 30, and a hand wheel 46 is secured upon the lower end of the shaft 45, which furnishes a convenient means for turning the cylinder. The casing 10, is provided with an opening 17 which exposes the front of the dial 41 to view.

The head 20 contains ports or passage ways 24, 25, which communicate with inlet and outlet nozzles 50—51. As shown in Figs. 2 and 4, the ports 24, 25, contain two upwardly extending portions that register with openings in the plug 12, which openings contain tubes 18, that extend down into the ports 24, 25. The nozzles 50, 51, are secured in the openings in the plug and extend up into the steam pipe, their open ends being preferably diametrically located at a point about 4/10 of the diameter of the pipe from the plug. The end of the inlet nozzle 50, is bent longitudinally of the pipe and opens in a direction opposite to the direction of movement of the current of steam, so that the inertia of the steam due to its velocity will put a pressure, greater than the statical pressure in the pipe, throughout the whole length of the passage communicating with the nozzle 50. As the nozzle 51 opens at right angles to the current of steam, the pressure in this passage is not raised by the inertia of the velocity of the steam flowing by the opening.

The ports 24, 25, contain downward extensions 24′, 25′, in which are interposed screw threaded plugs 26, 27, for controlling said ports. The plugs 26, 27, contain needle points 26′, that are adapted to close up the ports 24, 25, whenever the plugs are screwed home, and the plugs are provided with stems 27′, by means of which they may be operated. The port 24, is connected with a port or passage way 34, in the lower head 30, by a pipe 35, which as shown is threaded in bosses 28, 38, formed upon the heads 20, 30. The other ends of the port or passageway 34 and port 25 are connected by a glass sight tube 60, which is secured by means of stuffing boxes 61, in two nipples 28′, 38′ formed on the heads 20, 30.

An open continuous passageway is thus afforded which extends from the steam pipe A, through the meter and back into the steam pipe. The pipe 35, and port 34, form a sort of cistern or reservoir in which is placed a quantity of mercury, or other suitable liquid C, which is caused to rise in the sight tube 60 in proportion to the inertia of the steam flowing by, the velocity of the steam flowing through the pipe, causing a greater pressure on the mercury in the cistern than in the glass tube. The top of the column of mercury in the tube indicates upon the dial 41, the weight, in pounds, of steam flowing through the pipe per hour or other unit of time. The opening in the transparent or sight tube is very small compared with that in the tube 35 so that there is a large body of mercury in the well as compared with that in the sight tube when the two are on a common level, and a very slight displacement of the mercury in the well will cause a correspondingly great amount of movement in the sight tube. No movement of this mercury is effected by the statical pressure in the pipe but the mercury in the cistern will be depressed and mercury in the sight tube will be raised in proportion to the velocity of the steam flowing through the pipe. Condensation of the steam in the passage way above the mercury will not affect the operation of the meter, as the water in the tubes will be maintained at a constant level and no error can arise from the weight of the water on the cistern. A pressure gage 80, is connected to the passage way in the meter by a tube 81, and is arranged to indicate the pressure of the steam in the pipe A.

A slight modification is shown in Fig. 8. As here shown the plugs 26, 27, are placed in the connecting plug 12, and are arranged to close the ports therein. This construction provides means whereby the meter proper may be removed from the steam pipe without shutting off the steam from the latter. By first closing the ports 24^a, 25^a, by means of the screw plugs, the meter proper may be uncoupled from the connecting plug.

The weight of steam flowing through a pipe of given diameter, in a unit of time, depends on the statical pressure and the velocity of the steam. As the rise of mercury in the sight tube is proportional to the velocity, the top of the mercury column will indicate the weight, in pounds flowing through for the unit of time and statical pressure for which the dial is calibrated. As statical pressure increases and the same weight of steam passes through, the velocity would be less, therefore the rise of the mercury in the sight tube would be less and for this reason the weight line approaches nearer to the zero line or falls in direct proportion to the velocity. On the other hand, if the statical pressure decreases for the same weight of steam flowing through, the velocity must increase, therefore the mercury would rise higher in the sight tube and the weight line would rise on the dial. If the pressure is constant the mercury will rise in proportion to the velocity and therefore in proportion to the weight flowing through the pipe. By adjusting the dial until the statical pressure behind the sight tube on the dial is the same as that on the test gage 80, the top of the mercury will be on the line of the number of pounds flowing through the pipe in a given unit of time.

While I am aware that the weight of the steam flowing through the pipe can be determined by the formula $V=V_2gh$, I prefer to calibrate each meter and make the dial from the actual weight of steam passing through in the following manner: The meter is inserted between a source of steam supply, such as high pressure boilers and a surface condenser and with proper valves, different quantities of steam may be allowed to flow through under a constant pressure for a certain unit of time. By weighing the condensed steam, or water, and noting the height of the column of mercury, a series of points are obtained for different quantities or weights of steam flowing through for a constant pressure and for this unit of time. By continuing this operation for different pressures and connecting the points by a series of curved lines the dial may be calibrated, the accuracy of which can be proved by repeating the operation. When the meter is used for compressed air or gas under any pressure, it is calibrated for cu. feet of free air or cu. feet of standard gas. In measuring light fluids such as air or gas, a very slight displacement of the mercury occurs, and for this reason it may be found desirable to arrange the sight tube and dial on an incline, instead of placing them in the vertical position shown. A much longer movement of the mercury in the tube may thus be obtained by the same amount of vertical rise of the same.

In the drawings the gage reads 50 lbs. indicating that the pressure in the pipe is 50 lbs. By turning the dial until the numeral 50, at the top thereof, registers with the glass tube, it will be seen that the top of the column of mercury is opposite the curved line containing the number 500, indicating that the weight of steam flowing through amounts to 500 lbs. for the unit of time for which it was calibrated.

If the pressure in the pipe is greater or less than 50 lbs. the dial is turned to bring the proper column into register with the sight tube. Suppose that the pressure reads 80 lbs. pressure, and that the velocity of the steam remains constant, it will be found that the top of the column is at some point between the weight lines 500 and 550, thus indicating that a greater weight of steam is passing through during the given period of time. If now more steam be used, the velocity will become greater and the mercury will be forced higher up in the sight tube and the increase in weight will be noted upon the dial. By noting the static pressure and turning the dial to bring the proper column into register with the sight tube, the weight of steam can be observed directly on the dial.

I realize that various alterations and modifications of the device are possible and I do not therefore desire to limit myself to the particular construction shown and described, except as particularly pointed out in the appended claims.

I claim as new and desire to secure by Letters Patent:

1. In a meter, the combination of a movable dial, calibrated to indicate the weight of steam passing by during any given period of time and at various degrees of static pressure, a sight tube adjacent thereto, a well communicating with said sight tube, a body of mobile substance in said well, and nozzles communicating with said sight tube and well each opening into the fluid to be measured the nozzle communicating with the well pointing toward the moving column of fluid in a direction opposite to the direction of movement of the column.

2. In a meter, the combination of a rotatable dial, calibrated to indicate the weight of steam passing by during any given period of time and at various degrees of static pressure, a tube adjacent thereto, a well communicating with said tube, a body of mercury in said well and tube, and nozzles communicating with said well and tube and opening into the fluid to be measured, the nozzle communicating with the opening in the well being directed toward the moving column of fluid in a direction opposite to the movement of the column.

3. In a meter, the combination of a movable dial, calibrated to indicate the weight of steam passing by during any given period of time and at various degrees of static pressure, a well, an inlet nozzle directed toward the moving column of fluid to be measured and in a direction opposite to the movement thereof, a connection between the inlet nozzle and well a sight tube communicating with the well and with the fluid to be measured, and a body of mercury in said well and sight tube.

4. In a meter, the combination of a movable dial, calibrated to indicate the weight of steam passing by during any given period of time and at various degrees of static pressure, a sight tube adjacent thereto, a well communicating with said tube, a body of mercury in said well and tube, an inlet nozzle and an outlet nozzle communicating with the fluid to be measured, and connections between the inlet nozzle and well and between the outlet nozzle and sight tube.

5. In a meter, the combination of a movable dial, calibrated to indicate the weight of steam passing by during any given period of time and at various degrees of static pressure, a sight-tube adjacent thereto, a well communicating with the sight tube, a body of mercury in said well and sight tube, an inlet nozzle, and an outlet nozzle communicating with the fluid to be measured, connection between the inlet nozzle and well and between the outlet nozzle and sight tube and means for closing the entrance to the sight tube and well.

6. In a meter, the combination of a movable scale, calibrated to indicate the weight of steam passing by during any given period of time and at various degrees of static pressure a sight tube adjacent thereto, a well communicating with said tube, a body of mercury in said well and tube, inlet and outlet nozzles communicating with the fluid to be measured, connections between said inlet nozzle and well, and between said outlet nozzle and sight tube, and screw plugs in said connections.

7. In a meter, the combination of a casing, having a connecting plug for its connection with a suitable pipe, a sight tube, a well tube and a rotatable dial supported in said casing, said casing containing a channel connecting the bottoms of the sight tube and well, a body of mercury in the channel and tubes, an inlet nozzle communicating with the fluid to be measured and with the well tube and sight tubes respectively and an outlet nozzle.

8. In a steam meter, the combination of a casing, a well and sight tube, a rotatable dial supported therein, adjacent to the sight tube, inlet and outlet nozzles, connections

between the inlet nozzle and well and between the outlet nozzle and sight tube, and plugs in said connections.

9. In a meter the combination of a casing, a connecting plug, a connecting nut arranged to couple the casing to the connecting plug, inlet and outlet nozzles supported in said plug, a well tube and a sight tube supported in said casing, and communicating with the inlet and outlet nozzles, respectively, a connection between the other ends of the well tube and sight tube respectively forming a continuous passage from the inlet nozzle to the outlet nozzle, a body of mercury in said tubes and a movable dial supported in said casing.

10. In a meter, the combination of a casing, a well, a sight tube communicating therewith, inlet and outlet nozzles communicating with the fluid to be measured and with the well and sight tube respectively, a rotatable dial adjacent to the sight tube, and a hand wheel without the casing, connected with said dial.

11. In a meter, the combination of a cylindrical inclosing wall, top and bottom heads secured in said inclosing wall, an inlet nozzle, a tube communicating therewith, an outlet nozzle and a sight tube communicating therewith, a connection between the lower ends of said tubes, a body of mercury in said tubes and connection, and a dial rotatably movable in said casing adjacent to said sight tube.

12. In a steam meter, the combination of a steam pipe of practically uniform diameter, an inlet nozzle opening into said pipe, a well communicating therewith, a sight tube communicating with said well, an outlet nozzle opening into said pipe and communicating with said sight tube, a body of mobile substance in said well, and a suitably calibrated movable dial, arranged to indicate the weight of steam passing by during a given period of time, for various degrees of static pressure.

13. In a steam meter, the combination of a steam pipe of practically uniform diameter, a steam gage communicating with said pipe, an inlet nozzle communicating with said pipe, a well communicating with said inlet nozzle, a sight tube communicating with said well, an outlet nozzle communicating with said sight tube and opening into the pipe, a mobile substance in said well, and a movable dial calibrated to indicate weight of steam passing by during a given period of time and at various degrees of pressure.

14. In a steam meter, the combination of a steam pipe of practically uniform diameter, a steam gage communicating with said pipe, an inlet nozzle communicating with said pipe, a well communicating with said inlet nozzle, a sight tube communicating with said well, an outlet nozzle communicating with said sight tube and opening into the pipe, a mobile substance in said well and a movable dial having the quantity lines so curved that the height of the mercury will vary inversely as the statical pressure in the pipe for a constant velocity.

In witness whereof I have signed the above application for Letters Patent at Chicago, county of Cook and State of Illinois this 26th day of January 1907

CHARLES E. SARGENT.

Witnesses:
WM. P. BOND,
CHARLES O. SHERVEY.

PROBLEM V111.

PROBLEM
V111.

To construct a gas driven air compressor which would be self-contained simple in construction, cheap to build, which would require a minimum amount of floor space, and have a high mechanical and thermal efficiency.

THE NECESSITY OF SUCH A PRIME MOVER.

The most necessary auxiliary for an internal combustion engine installation is an air compressor for providing a storage of air under pressure for starting the engine. A safe rule is to furnish four-tenths cubic feet of air at the compression pressure for each brake horsepower of the largest engine in the installation. For a 500 H.P. engine, 200 cubic feet is all that is necessary, and an air tank of this capacity filled at compression pressure, if the engine and ignition apparatus are in good condition, will start a 500 H.P. engine two or three times.

Where gas engine driven pumps are used for high duty fire service, an air tank, for reliability, is desirable for each engine. The usual compressor plant manufactured or purchased for a gas engine installation, consists of a gasoline or gas engine, which can be started by hand, belted to an air compressor. Such an outfit must have two foundations, requires considerable and often valuable floor space, needs separate cooling water for engine and compressor, a separate oiling system, and from the writer's experience, requires more attention than at least one of the big prime movers of the plant.

While an air compressor for the intermittent service of a gas engine installation need not be as efficient as one in continual operation, it was deemed advisable to take into consideration simplicity, efficiency, low cost

and easy manipulation in bringing out a new design in order that it could be used for any purpose, and in order to properly comprehend the problem, the usual losses in compression will be discussed.

Air is heated in undergoing compression, but before the compressed air can be utilized this heat has been radiated and lost; it is, therefore, important that the greatest possible cooling of the air be accomplished during the process of compression, thus reducing the power necessary for compression as well as simplifying the lubrication problem. This is partially done by surrounding the cylinder in which the air is compressed with a water jacket, which cools that portion of the air adjacent to the cylinder walls, lowering its average pressure. In order to increase the cooling surface and materially reduce the temperature of the air, two and three cylinders with inter-coolers are used. These refinements increase the thermal, but lower the mechanical efficiency, yet as long as the heat of compression is developed throughout the mass and as long as air remains such an excellent non-conductor, the heat generated near the center of the cylinders will not be absorbed by the water jackets, and a high thermal efficiency will not be obtained.

The cooling surface in air compressors may be largely increased by compressing the air in a thin annular chamber, having a large surface compared to the volume compressed, and as the distance the heat has to travel to get to the water cooled surface is short, the absorption of the heat of compression is comparatively rapid.

SOLUTION.

A self-contained gas driven air compressor in which this feature is incorporated in shown in Fig.1. It is a vertical single acting four cycle gas engine and a two stage direct driven air compressor with but one piston, one connecting rod and one crank. The engine intake and exhaust valves and the inlet valve to the first stage of the air compressor are positively controlled,

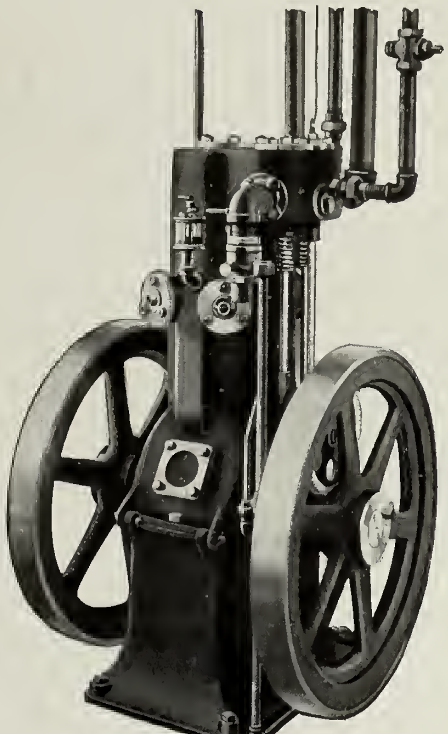


Fig. 1

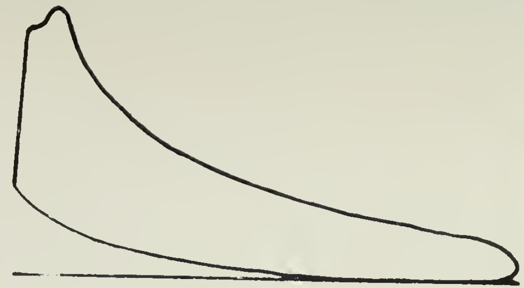


Fig. 7

Fig. 5

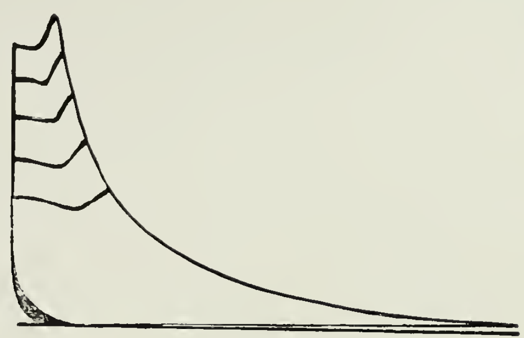


Fig 6

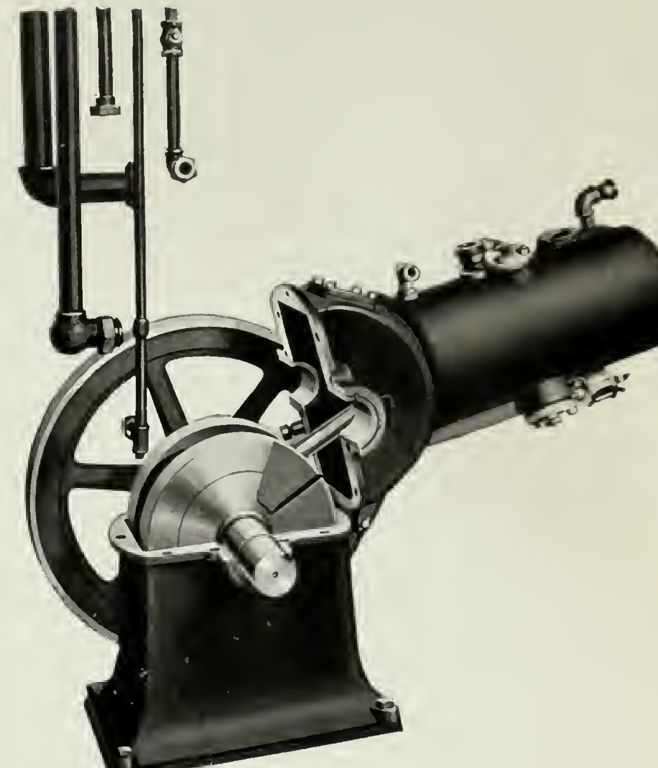


Fig. 4

while the second stage compressor valves are automatically opened and closed by the air under compression.

Fig. 2 is a vertical section through cylinder and base, showing the heavy crank shaft, connecting rod and differential piston.

Fig. 3 is a side elevation with one flywheel removed, showing gas engine valves in section and the cylinder wall broken away, disclosing piston and the second stage air compressor valves. Upon a single flaring cast iron base,in which the crank bearings are babbitted, is bolted the differential water jacketed cylinder, containing the piston, connecting rod and crank. Liners between the cylinder and base allow for adjustment of crank shaft bearing. Hand hole plates (Fig.3) are provided for adjusting the babbitted crank pin box. The upper end of connecting rod which is always in compression is a large hollow steel ball permitting the piston to rotate at will, insuring an even and minimum wear of both piston and cylinder. When looking at the governor side (Fig.3) engine runs clockwise and the piston is moving down on the working stroke.

The inlet valve A and the exhaust valve B which open into the explosion chamber C are closed. As the piston D approaches the end of the working stroke the cam L engages the roller M, which, through the valve rod (broken away in Fig.3) opens the exhaust valve B, holding it open until the end of the exhaust stroke. As the cam L leaves the roller M it engages the roller O, opening the admission valve A during the suction stroke. If the engine is using gas for fuel the collar on the valve stem A allows gas from R to flow into the cylinder C with the air, the amount of gas being regulated by a graduated cock on valve chest.

The speed of the engine is controlled by the inertia weight S pivoted to the bell crank which carries the exhaust roller M. When engine runs above normal speed the weight S hangs back, stretching the spring T, permitting the steel plate U to engage V, thereby holding open the exhaust

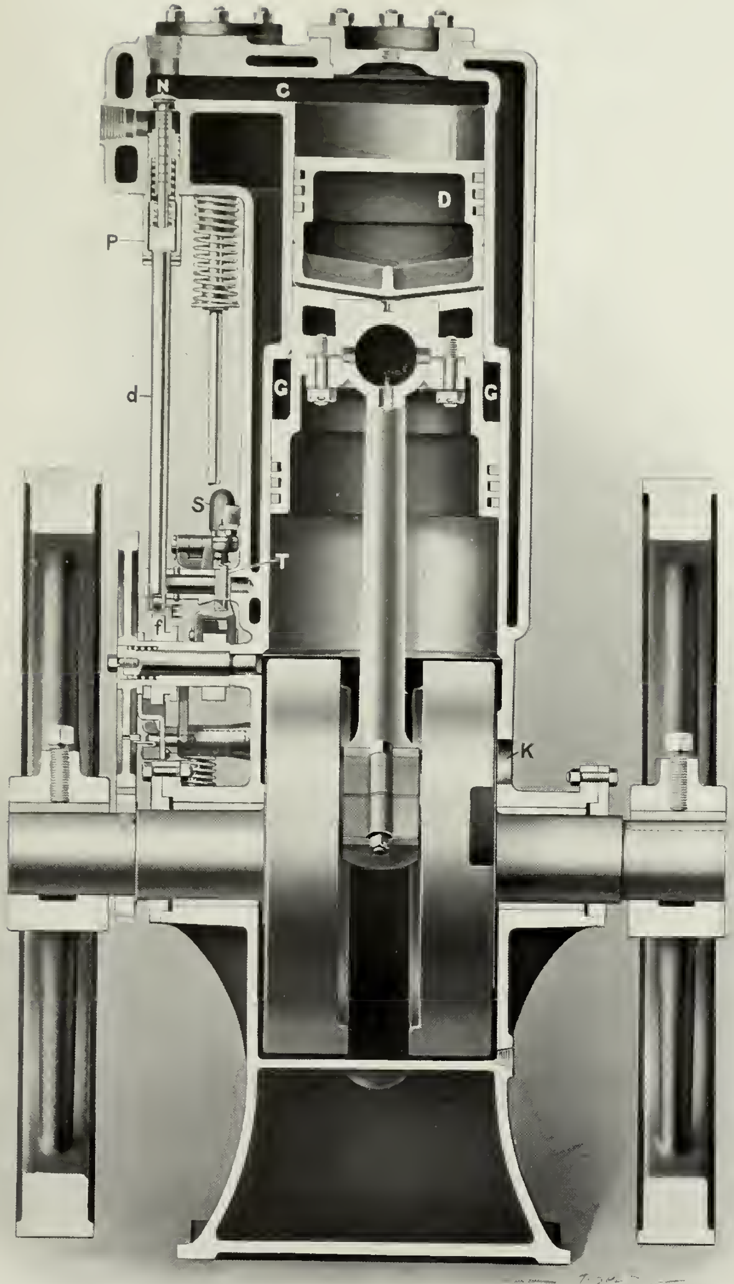


Fig. 2

valve B during the suction stroke. When U engages V link J holds inlet valve stem W in such a position that the lifting plate X misses W keeping the suction valve shut and fuel from entering the combustion chamber. As soon as the speed drops, plate U misses notch V and the regular cycle takes place.

Engine may be started by hand or by compressed air which it has previously compressed. The starting valve N (Fig.2) between the inlet and exhaust valves A and B is normally held to its seat and against suction by the spring, which also holds the plug P, stem d and roller e as high as the flange on P will permit. This is sufficient to raise and hold the roller e above the path of the cam f and in its normal position.

When piston is at the beginning of working stroke compressed air is admitted through a pipe (Fig.1) to the space between the valve N and plug P. On account of the cam f and the roller c preventing the plug P from being forced down and holding the valve N closed, air raises this valve, and flowing into cylinder, gives a sufficiently strong impulse during the working stroke to start the engine. As soon as piston reaches the end of this stroke cam f passes roller e, allowing the air to hold the valve N closed until another working stroke is reached, when air is again admitted, unless the pressure from an explosion is greater than that of the compressed air, when engine will operate from its own power.

When the differential piston D is at the top of the stroke the crank case is full of air at atmospheric pressure, having entered through the port K which registers with the port in disc (Figs.2 and 4). Upon the downward stroke this air is compressed in the crank case and flowing through the passage F and valve E fills the annular chamber C, raising the absolute pressure to about twenty pounds, when the valve E closes and the piston starts on the up stroke.

As soon as the pressure in the annular space G reaches the pressure

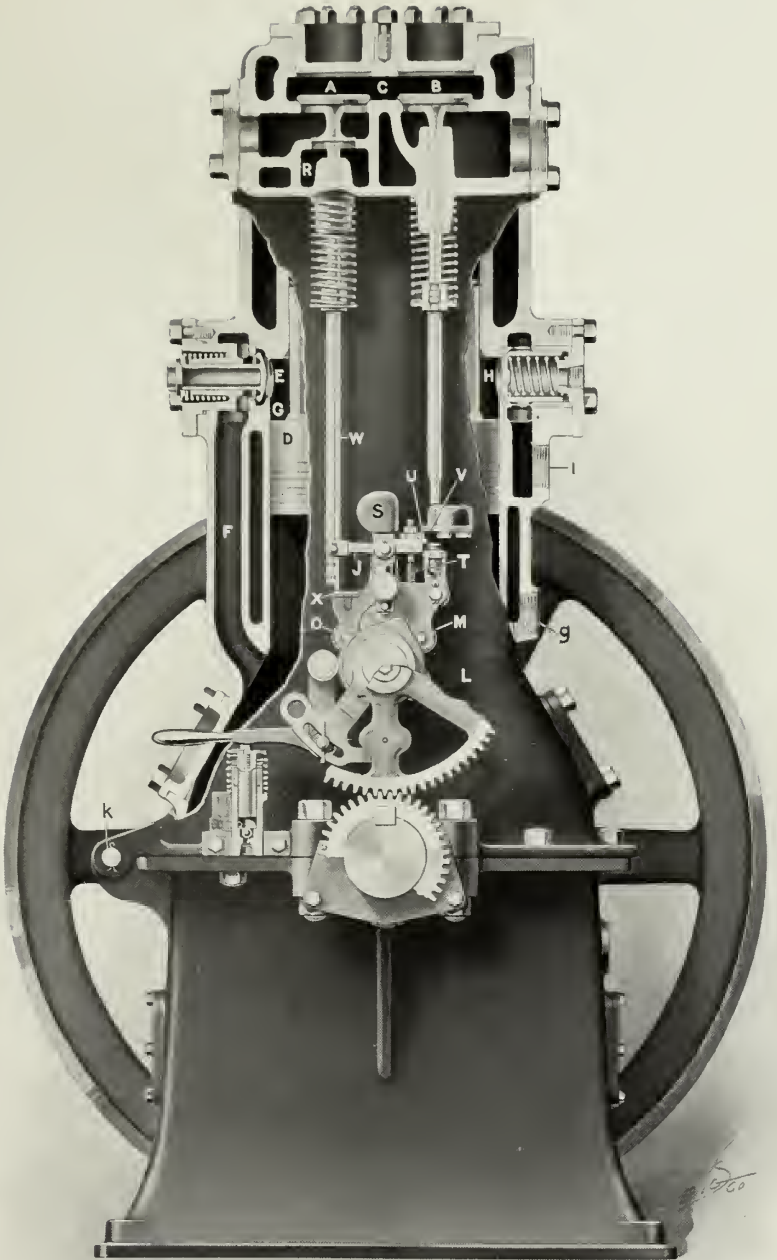


Fig.3

in the receiver the discharge valve H opens. As the pressure in the crank case assists the piston on the up stroke, and the port on disc is so located that it does not open the port K until atmospheric pressure is reached, no work is lost, and a high efficiency is maintained. As there are two compressions of air to one working stroke in the engine, two flywheels and heavy crank discs practically filling the crank case and reducing the clearance, furnish plenty inertia to maintain sufficiently uniform speed.

While it is desirable in an internal combustion engine to have an explosion chamber with a minimum surface per unit of volume to prevent loss of heat, an air compressor for efficiency should have a maximum cooling surface per unit of volume to keep the air cool. The explosion chamber in the power cylinder has as small a surface as possible consistent with direct lifted valves, and the annular space in which air is compressed has nearly four times the cooling surface per unit of volume found in the ordinary air compressor.

As the water around a compressor cylinder should be as cold as possible and around the explosion chamber of a gas engine as hot as possible for a combined maximum efficiency, the cold water enters the jacket at g and passing entirely around compressor cylinder rises and absorbs heat from the compressed air, and is sufficiently warm when it reaches the gas engine jacket to maintain a high thermal efficiency throughout the combined cycle.

Pipes for the hot water outlet, the water inlet, compressed air, starting air and exhaust are connected to the back side of the engine and by removing the bolts which hold the cylinder to base, and disconnecting the pipe flanges it may be revolved back on the hinges k (Fig.3) for inspection or adjust-shown, as shown in Fig.4.

In sizes having a capacity of 33 cubic feet or more or free air per minute, there are two or more admission and discharge valves of the most approved design, having large port area and low lift.

Air admission and discharge valves are of a light approved design, and are readily examined by removing three nuts. On account of the valves opening radially and their location, a minimum clearance is realized. The working of the admission valves can be seen when engine is in operation.

A sight-feed cylinder lubricator oils both ends of the differential piston. Surplus oil gathered up by the periphial groove cut in piston delivers it through drilled holes to the ball and to the crank pin through a hole in the center of connecting rod. Grease cups lubricate crank shaft bearings and provide an effectual air seal.

The indicator diagram, Figure 5, taken from the crank case with a twenty pound spring shows the work done in the first stage of compression. The diagram, Figure 6 was taken from the annular chamber with a hundred pound spring when delivering air at sixty, eighty, one hundred, one hundred and twenty, and one hundred and forty pounds, respectively. Figure 7 is a diagram from the explosion chamber. The minimum re-expansion of air in the lower left hand corner of Figure 6 indicates the high volumetric efficiency obtained. On account of the large cooling surface per unit of volume and short distance for the heat to travel, the compression approaches very closely the isothermal line, insuring a high thermal efficiency and low cost for compressed air.

An account of this compressor being single acting and the piston always resisted by compression during the upward stroke, a clearance of not to exceed .015 is entirely feasible, and as the valves and cages come almost flush with the inner wall, the reason for the high volumetric efficiency shown in diagram is apparent.

The most economical internal combustion engine, other things being equal, is the engine with a hit and miss governor. When delivering air under low pressure this compressor engine will tend to run faster than the

speed at which it is set, in which case the governor will operate and hold the exhaust valve open, and the admission valve closed for one or more revolutions until the engine drops to normal speed.

On account of the low mechanical friction, thorough cooling of the compressed air, absence of all stuffing boxes, small clearance and few moving parts, the efficiency of the compressor is very high.

Compressor runs on kerosene, gasoline, natural, illuminating or producer gas; it uses the same water to keep the gas engine cylinder from getting hot that it uses to keep the air cylinder cool. The operation of this engine compressor is all that could be desired.

PROBLEM 1X.

PROBLEM
IX.

To redesign a rotary valve vacuum cleaning machine which could be manufactured for 50% less, which could not wreck itself with entrapped water, and which would have an increased capacity of 75%.

ARGUMENT:

Fig. 1 is the side elevation of a four sweeper rotary valve vacuum machine, designed for sweeping by the vacuum system. The base is filled about half full of clean water. An opening under the water level is connected to a vertical riser, having openings at different floors of the building in which the machine is installed, for hose and sweeper attachments. On top of tank there is a reciprocating vacuum pump, the opening and closing of the ports of which are controlled by a hollow rotating plug valve driven by gearing from the crank shaft at crank shaft speed.

When it is desired to sweep, electric motor which is belted to pump is started, air is drawn out of the cast iron base and from the riser, through a rotary scrubber running under water, belted from the crank shaft as shown. The pressure of the atmosphere in the rooms being swept, drives the air and dirt from the floor through the sweeper, hose, riser and scrubber, and out into the atmosphere or out of doors through the pump cylinder exhaust. Ninety per cent of the dirt is left in the cleaning water.

When finished sweeping, riser is cut off by shutting a valve between it and tank, and a valve between tank and sewer is opened. The shaft between crank and valve is uncoupled and valve is revolved 180°, converting the vacuum pump into an air compressor. Upon starting the motor air is forced

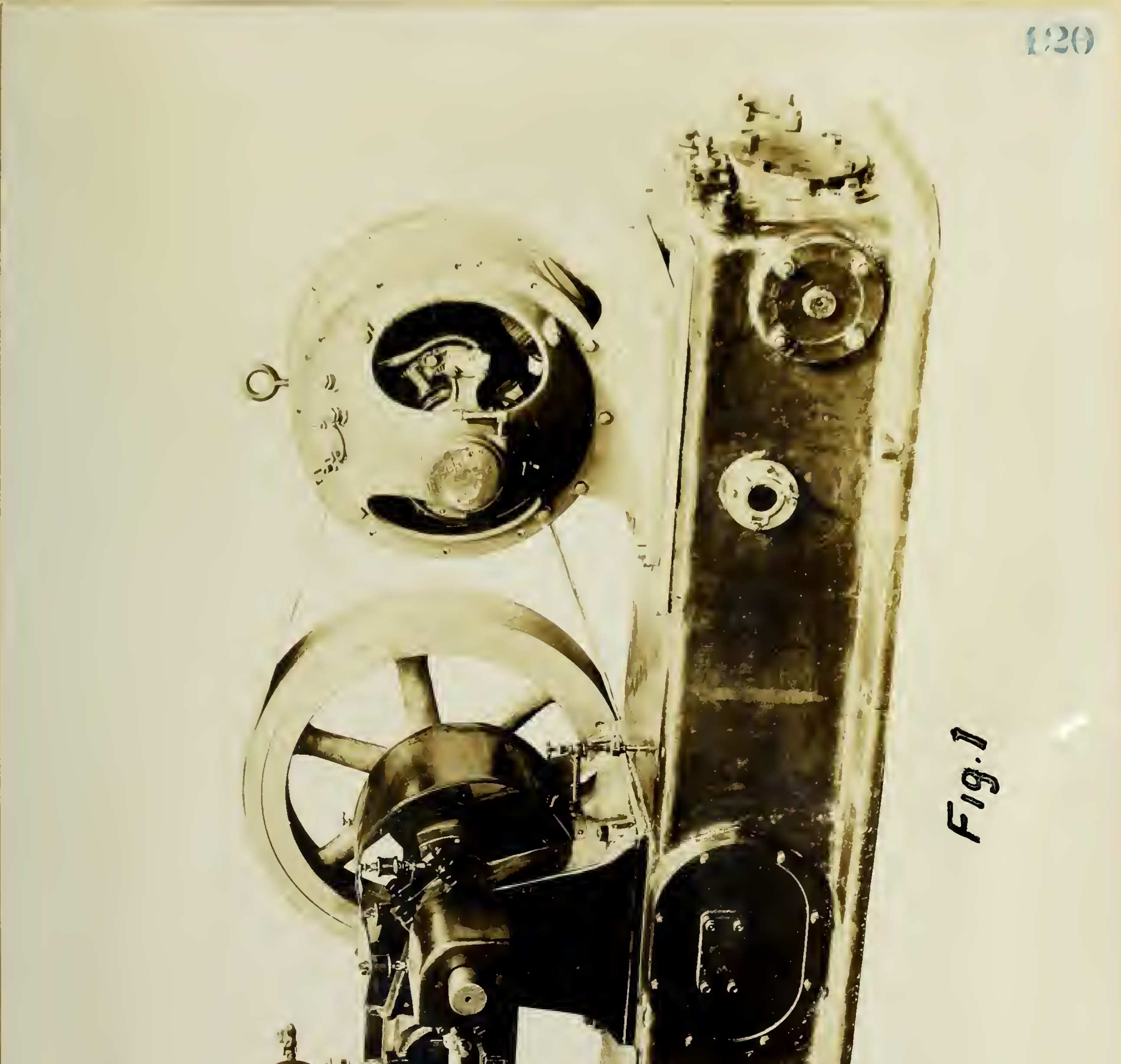


Fig. 1

into tank and drives the dirty water to the sewer.

About twelve inches of mercury is the best vacuum for sweeping when small quantities of air are used. If the pump is in operation and two or three sweepers are cut off, the vacuum would so increase that the operating sweeper would pull the rugs from the floor. To overcome excessive vacuum there is a bronze unloader on top of cylinder which opens a port between both ends of cylinder when a predetermined vacuum has been reached. In the machine described this unloader assembled weighed about eighty pounds, and required about one hundred and fifty hours of machine work to complete it. In order to keep down the weight the bypass port of unloader was restricted, so that when the unloader valve became operative it required as much power to drive the air back and forth from one end of the cylinder to the other as it did to maintain a twelve inch vacuum. On account of this restricted bypass port area, and the construction of the unloader and pump cylinder, it was impossible to run the pump faster than 180 R.P.M. without raising the vacuum too high for sweeping.

The rotary valve is on the same level as the piston, and only about one-half the diameter, therefore any water drawn up during the surging of the water in the base would pocket in cylinder, often wrecking piston and rod. The frame was open, allowing the dirt and dust to get into working parts, and the oil to fly out. A pair of bevel and a pair of spur gears drove the valve shaft. About a dozen sight feed oilers required the attention of the operator. While the machine did good work, it often wrecked itself with water; it cost too much to build for its capacity; it was noisy and dirty and not commercial.

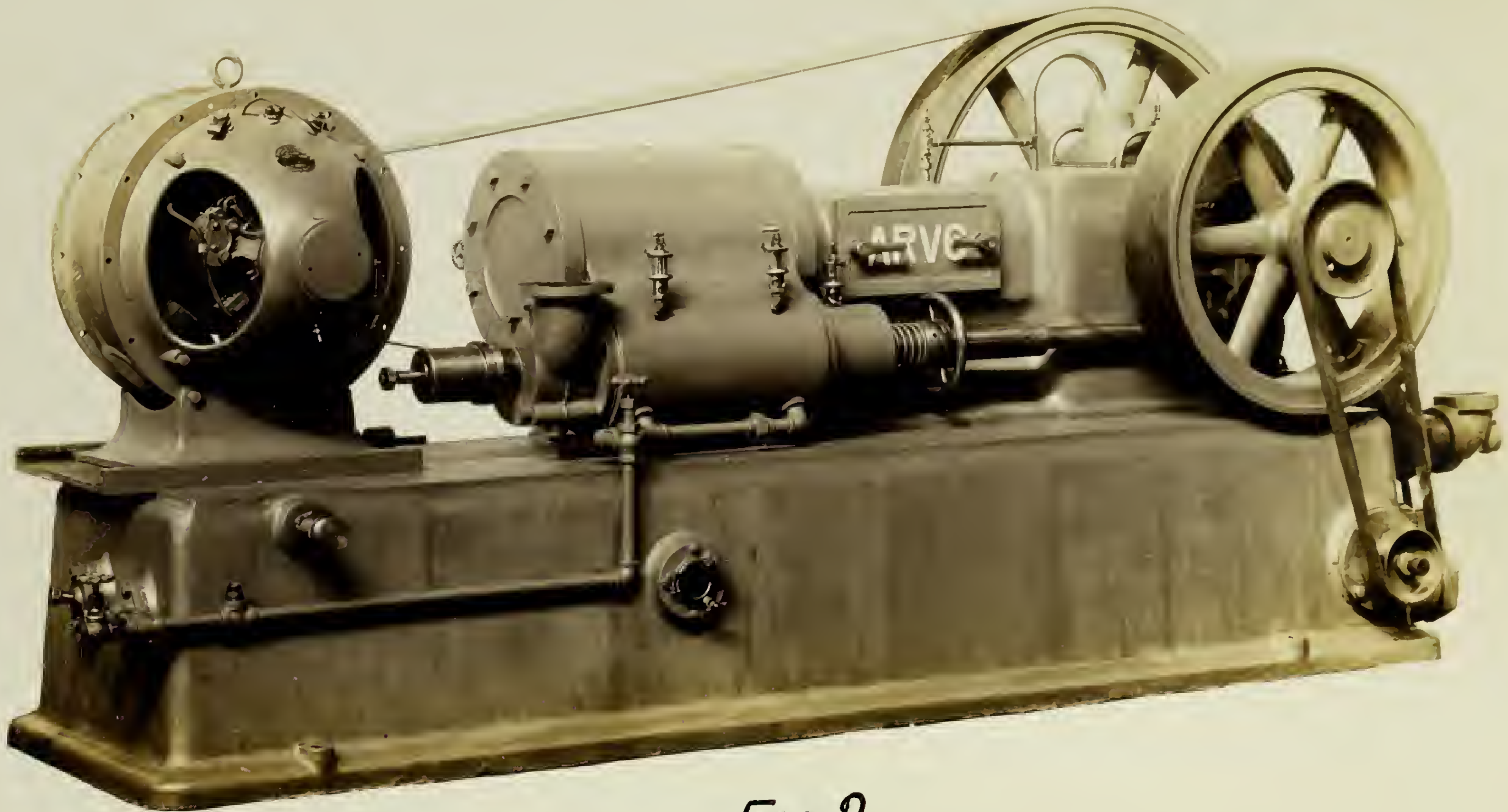


Fig. 2

SOLUTION.

In order to make a vacuum pump of this style a commercial success it was necessary first to put the valve in such a place that entrailed water would run out of cylinder with the discharged air. Second: to design a bypass which would not only hold the vacuum where required, but which would unload the pump, reducing the current consumed until pump was again cut in. Third: to so enclose the working parts that oil could not get out and dirt could not get in. Fourth: to make sufficiently large ports so a higher speed could be maintained and more sweepers operated at one time.

Fig.2 is a photograph of the redesigned vacuum machine. The valve is below the center of cylinder, permitting the water to flow out by gravity. The working parts are all enclosed and self-oiling. The valve is driven by a pair of spiral gears, the axes of which are, of course, at right angles to each other, and not in the same plane. These gears running in a housing act as an oil pump and pump oil to all working parts (specification No.644149) and the overflow passes through a filtering medium back to crank case and through system again. The unloader was entirely eliminated, and the valve itself so designed that when a predetermined vacuum was reached it would move endways by the pull of the vacuum, by-passing the suction and cutting the watts in half. If in compressing the pressure raised too high, valve would move the other way, holding a constant pressure in the tank. On account of a moving valve being more susceptible to a slight variation in pressure than a stationary valve, the success of the unloader was assured from its first conception.

This machine would handle seven sweepers at 300 R.P.M. or 75% more than the one it supplanted, and weighing/ more, cost nearly 50% less to build than the machine illustrated in Fig. 1.

So successful was this new model that the largest vacuum machines ever constructed were designed by the author for the new New York postoffice on the same lines, using two tandem cylinders (Fig.3).

Fig.3

No. 644,149

Patented Feb. 27, 1900.

C. E. SARGENT.

LUBRICATING DEVICE FOR ENGINES.

Application filed Nov. 1, 1899.

(No Model.)

2 Sheets—Sheet 1

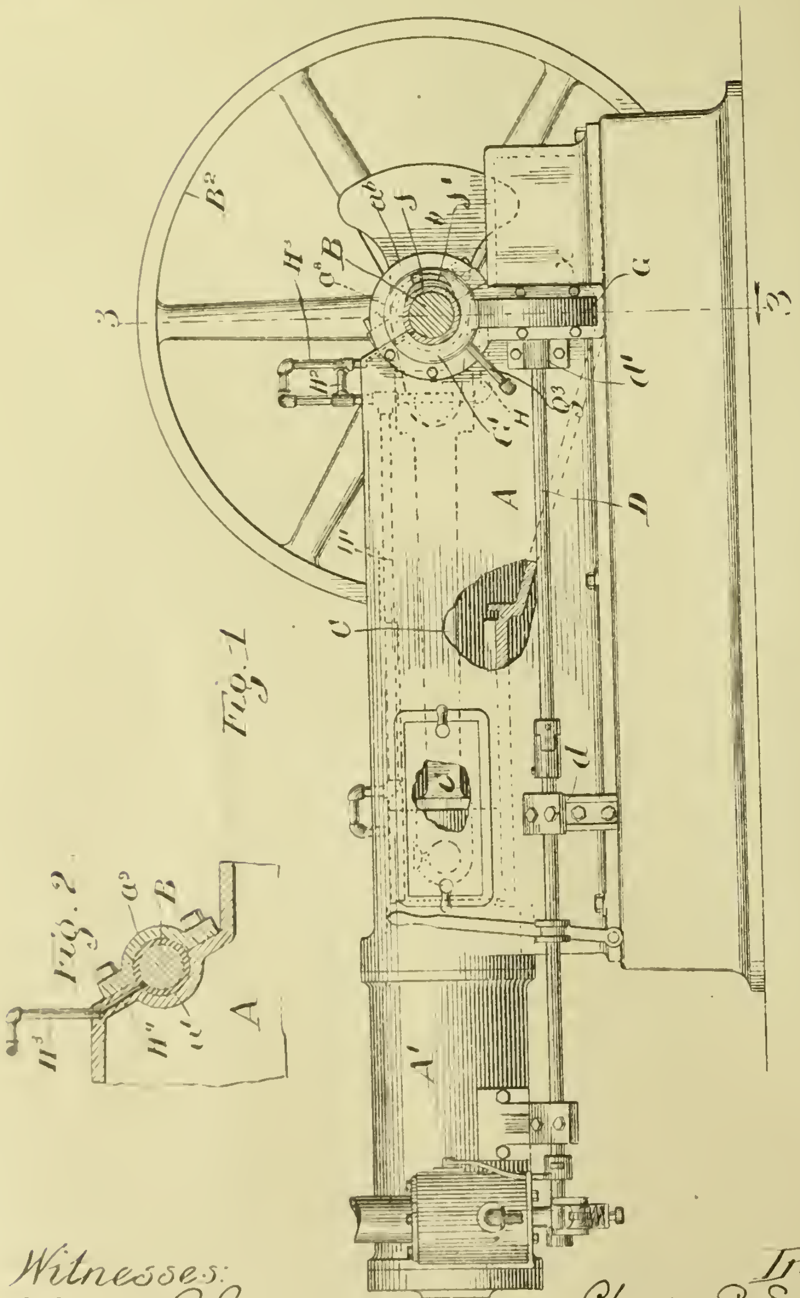


Fig. 1

Fig. 2

Witnesses:
Chas O. Shervey
S Bliss

Inventor:
Charles E. Sargent
by Wiles Greene & Bitner,
Attys.

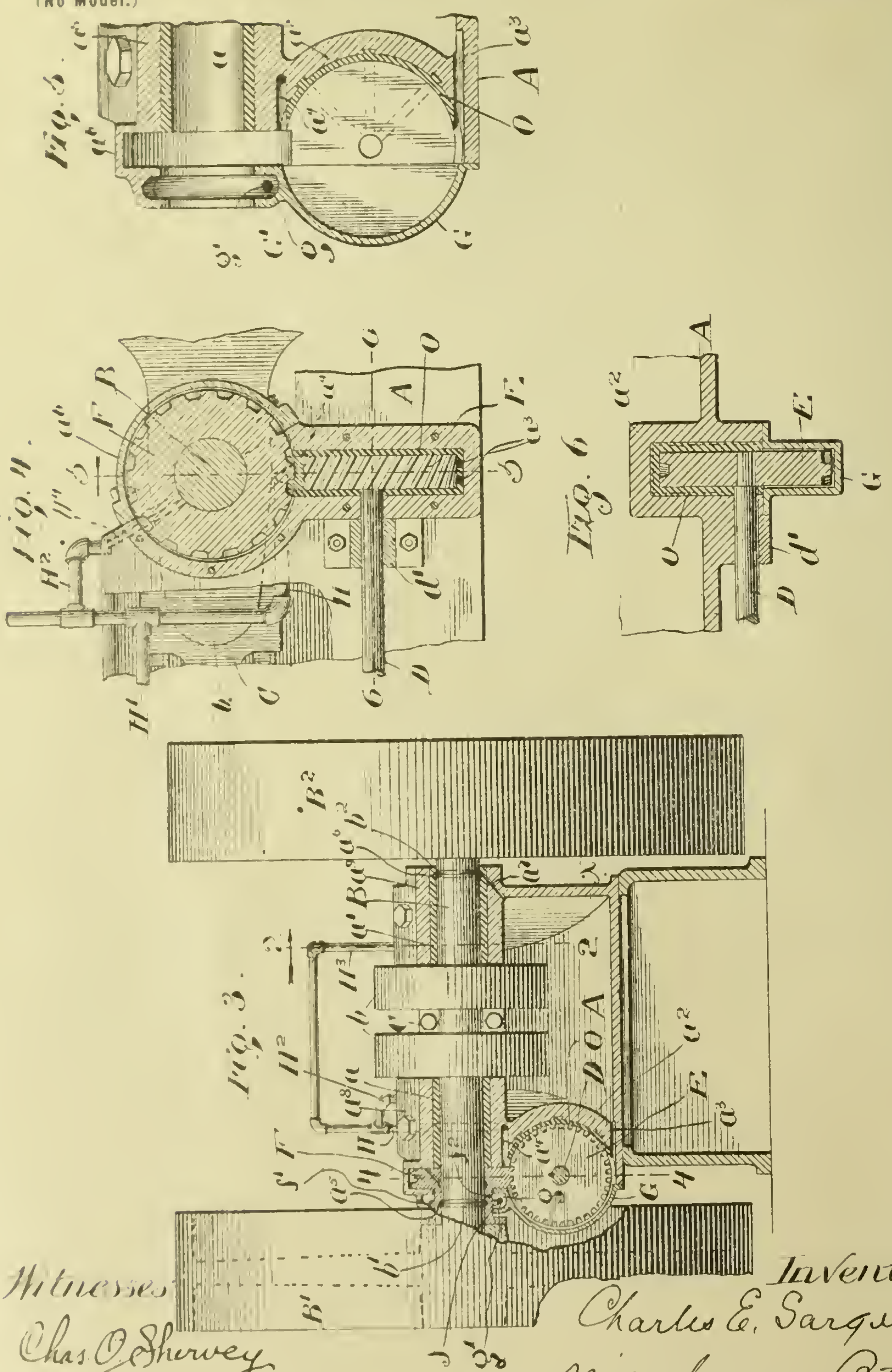
No. 644,149. Patented Feb. 27, 1900.

C. E. SARGENT.

LUBRICATING DEVICE FOR ENGINES.

(Application filed Nov. 1, 1899.)

(No Model.) 2 Sheets—Sheet 2.



Witnesses:
Chas. O. Shervey
S. Bliss.

Inventor:
Charles E. Sargent
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Attys.

UNITED STATES PATENT OFFICE.

CHARLES E. SARGENT, OF CHICAGO, ILLINOIS.

LUBRICATING DEVICE FOR ENGINES.

SPECIFICATION forming part of Letters Patent No. 644,149, dated February 27, 1900.

Application filed November 1, 1899. Serial No. 735,474. (No model.)

To all whom it may concern:

Be it known that I, CHARLES E. SARGENT, a citizen of the United States of America, residing at Chicago, in the county of Cook and State of Illinois, have invented certain new and useful Improvements in Lubricating Devices for Engines, of which the following is a specification.

My invention relates to a certain class of engines, mostly of the internal-combustion type, in which the valves are operated from the driving-shaft by certain interposed gears adapted to communicate motion to the valves by means of a connecting-shaft, the object of the gears being to control the motion of said shaft and also the direction of the same.

The object of the invention is to utilize the said gears to maintain a constant circulation of oil through the working parts and bearings of the engine, using the same oil over and over again and keeping a constant supply at the points where it is needed.

To such end the invention consists in certain novel features, a description of which will be found in the following specification and the essential features more definitely pointed out in the claims.

The invention is illustrated in the drawings furnished herewith by means of six figures, of which—

Figure 1 is a side elevation of an engine with certain portions broken away to illustrate other more important portions. Fig. 2 is a vertical cross-section in line 2 2 of Fig. 3. Fig. 3 is a vertical cross-section in line 3 3 of Fig. 1. Fig. 4 is a detail longitudinal section in line 4 4 of Fig. 3. Fig. 5 is a vertical cross-section of a portion of the frame of the machine, the line of section being indicated at line 5 5 in Fig. 4; and Fig. 6 is a horizontal section in line 6 6 of Fig. 4.

Referring to the drawings, A represents the bed of the engine, and A′ the cylinder, which is provided with the ordinary valves used in engines of this class. The main driving-shaft B is journaled in bearings a a', provided with caps a^8 a^9, and carries upon its ends fly-wheels B′ B^2. At its middle portion it has a preferably integral double crank b, on which is pivoted the connecting-rod C, the latter being secured to the piston in the ordinary manner. The valves are operated by a shaft D, journaled in boxes d d', secured to the bed of the machine and carrying upon one end a spiral gear-wheel E in mesh with a second spiral gear-wheel F, secured to the main driving-shaft B.

The bed of the machine is formed with a socket a^2, in which one half of the gear E lies; and a cap G is bolted to the frame, as seen in Figs. 1 and 5, to inclose the other half of said gear. The latter runs in Babbitt metal O, which is poured into the socket a^2 to make a perfect fit between the gear and the surrounding walls. The Babbitt metal is preferably run in after the blank gear has been trued up, but before the teeth have been cut in same, the gear having been mounted upon the shaft and fitted to its place in the socket. This makes a perfectly-smooth bearing between the outer peripheries of the teeth and the surface of the Babbitt metal, which is quite essential to the perfect operation of the device. The cap G extends upward and also incloses the greater portion of the gear F, as seen at G′. (See Fig. 1.)

The bed of the machine is preferably so constructed as to form a reservoir or tank in which a quantity of lubricant may be stored at a convenient point. This tank is shown at X in the drawings and should preferably be located as near the parts of the engine which use the most oil as possible. Looking at Fig. 3, it will be seen that openings a^3 are formed in the wall of the socket a^2 and in the Babbitt metal to permit the oil to flow into the chamber occupied by the gear E. At the top of this chamber is formed a second opening a^4, communicating with a pipe H, which may extend to any of the parts of the machine which require oiling. The pipe in the drawings is shown as having a branch H′, running to the cross-head of the engine, and branches H^2 H^3, extending to the bearings of the main driving-shaft B. In Fig. 2 it will be seen that the branch H^3 connects with a port H^4 in the frame, which extends to the shaft B. The branch H^2 is similarly connected to the shaft B. The shaft is preferably formed with ribs b' b^2, running in grooves a^5 a^6. The groove a^5 is formed in a boss f, the gear F and the groove a^6 in the bearing a', the object of the same being to prevent the flowing of oil out upon the shaft beyond the bearing a and gear F. A port a^7 connects the groove a^6 with the interior of the bed and allows oil to run from the bearing back into the bed of the machine. The collar f embraces the shaft B and is formed with an annular rib f', rotating in a channel g, formed in the upper portion G' of the cap, said rib f' being adapted to stop any flow of oil which may escape from the chamber in which the gear F travels. An aperture f^2 in the collar f of the gear F communicates with the channel g and allows the oil to flow from the shaft B into said channel g. An aperture g' is formed in the cap G and communicates with the interior of the bed of the machine through a pipe g^3, (see Fig. 17) conveying the oil which collects in the channel g to the reservoir X. The cap a^8 is formed with a hood a^b, (see Figs. 4 and 5,) which, together with the upper portion G' of the cap G, completely incloses the gear F and prevents any oil from getting out of the engine at this point.

The oil in the reservoir X flows by gravity through openings a^3 into the socket a^2 and fills the spaces in the teeth of the gear E. As these pass upward from the openings a^3 the oil becomes penned in between the sides of the gear and walls of the socket until it reaches the gear F. As the teeth of the latter advance in the gear-wheel E they force the oil out from between the teeth of the latter through the port a^4, from which it passes to the pipe H and thence to the various parts of the engine through the connecting-pipes before described. After it has performed its work in lubricating said parts it flows by gravity back to the reservoir and cools off for another round.

The value of the invention herein disclosed will be recognized when it is considered, first, that the series of gears between the main driving-shaft and the valve-operating shaft are a common and desirable feature of engines of this class; second, that said gears should run in oil for their own lubrication, and, third, that devices should be provided for maintaining a constant circulation of oil through the said gears and also through the other working parts of the engine. All of these desirable features are attained by the simple expedient of babbitting a portion of the gear-casing and providing connecting-passages between the gears and the reservoir, the gears and the working parts, and the working parts and the reservoir.

I claim as new and desire to secure by Letters Patent—

1. The combination, in an engine of the class described, of a frame, a cylinder, suitable valves, a main driving-shaft, a piston connected therewith, a valve-operating shaft, a series of gears between the driving-shaft and the valve-operating shaft, a reservoir located below the working parts, a passage leading from the reservoir to one of said gears, passages leading from another point of said gear to the working parts of the engine, passages leading from said working parts to the reservoir and an approximately oil-tight casing about the said gear, whereby the same operates both to pump the oil from the reservoir to the working parts and to operate the valves; substantially as described.

2. In an engine and in combination with the working parts thereof, a reservoir below said working parts and connected therewith by suitable passages, a babbitted casing having an inlet and an outlet port, a passage connecting the inlet-port with the reservoir, passages connecting the outlet-port with the working parts of the engine, a gear in the casing, a second gear in mesh with the first and connections between said gears and the working parts of the engine for driving the gears; substantially as described.

In witness whereof I have hereunto set my hand, at Chicago, in the county of Cook and State of Illinois, this 28th day of October, A. D. 1899.

CHARLES E. SARGENT.

Witnesses:
CHAS. O. SHERVEY,
S. BLISS.

PROBLEM X.

PROBLEM
X.

To develop a centrifugal governor for a Single Phase Linotype Motor which would allow it to start as a splitphase repulsion type and to change at a predetermined speed to an induction type.

THE DEMAND FOR SUCH A MOTOR.

Linotype machines are found in nearly every newspaper office in the United States, each requiring a small motor of some kind to drive it. Type casting machines, like type setting and textile machinery, require a regular speed for efficient service. On account of reliability, inattention and cost, electric power is nearly always preferred and usually available.

The kind of an electric motor required for Linotype machines will depend on the current available. Direct current compound wound motors, either 110 or 220 volts, regulate satisfactorily for this exacting service. Polyphase motors are used in some offices, and govern exceedingly well with change of load.

The only unsatisfactory motor which the company furnished for driving Linotype mechanism was the single phase of the repulsion type with a commutated current, which, having the characteristics of a D.C. series machine, would vary in speed with the load as much as twenty to twenty-five per cent.

Linotype operators put up with this vacillating speed as long as they were operating the old style apparatus, but the new Linotype model ran so much lighter and faster that a better single phase motor had to be furnished. As the Linotype machines were originally designed for belt drive, a motor to fit in the only available space had to be thin and large and slow speed, Figure 1.

By winding this motor, which was of the squirrel cage type as an induction motor only, the regulation would be good, but it would not start; by

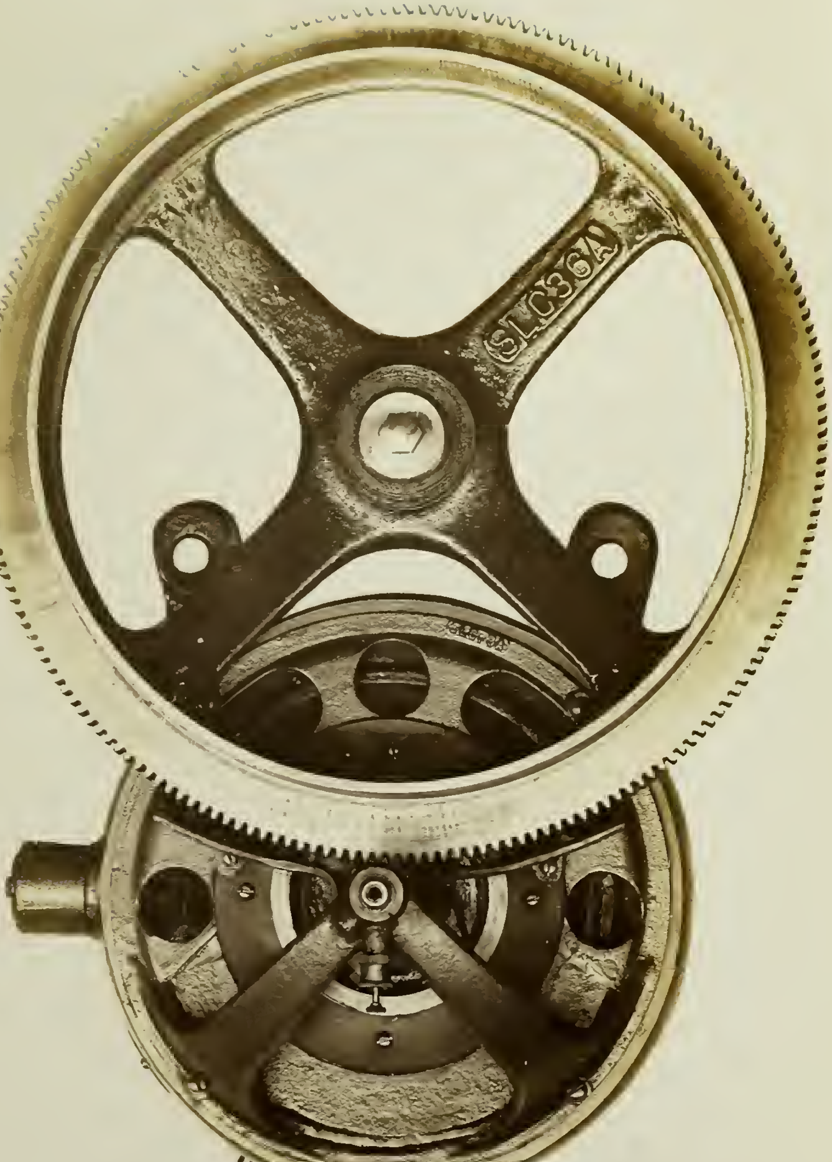

Fig. 1

the introduction on the stator of another winding having a different impedance, the two being ninety electrical degrees apart, a splitphase effect would be obtained when both were excited, giving a starting torque which would bring the motor up to speed. The secondary winding used only in starting and having such low resistance, would burn out in a short time if its current were left on.

The normal speed of motor was about 900 R.P.M. Comparatively large currents would flow through the starting winding, giving sufficient torque to bring motor up to speed in about one second. The problem was to design a centrifugal switch which would open the starting circuit at about 700 R.P.M., open it with a quick break to prevent arcing, and keep it open until motor dropped back to about 300 R.P.M.

SOLUTION.

Figure 1 shows the motor with switch in place; Figure 2 shows the end view of switch; Figure 3 shows the section on A.B. The cast iron rings C.C', insulated by the fibre ring D, are all stationary and fastened concentric with the shaft with four screws to the frame.

Mounted on the shaft E between the armature and front bearing is the counterweight F, to which is attached the centrifugal weight G by the pin H. Mounted on this weight G, and insulated therefrom is a bifurcated brush J, which short circuits the rings C.C' in its normal and stationary position. The centrifugal weight G is held against the counterweight F by the spring K, which is fastened to the counterweight at L, and to the centrifugal weight by the pin M. The armature and revolving weights rotate in the direction of the arrow. The centripetal force of the spring balances the centrifugal force of the weight G at 700 R.P.M. As the speed increases slightly, the centrifugal force of the weight exceeds the holding effect of the spring and G begins to move. Now as the leverage or distance between the center line of spring and the fulcrum H gets less as G flies out, and as the force tending to pull G out increases, directly as the distance the center of gravity of G is from the center of shaft E,

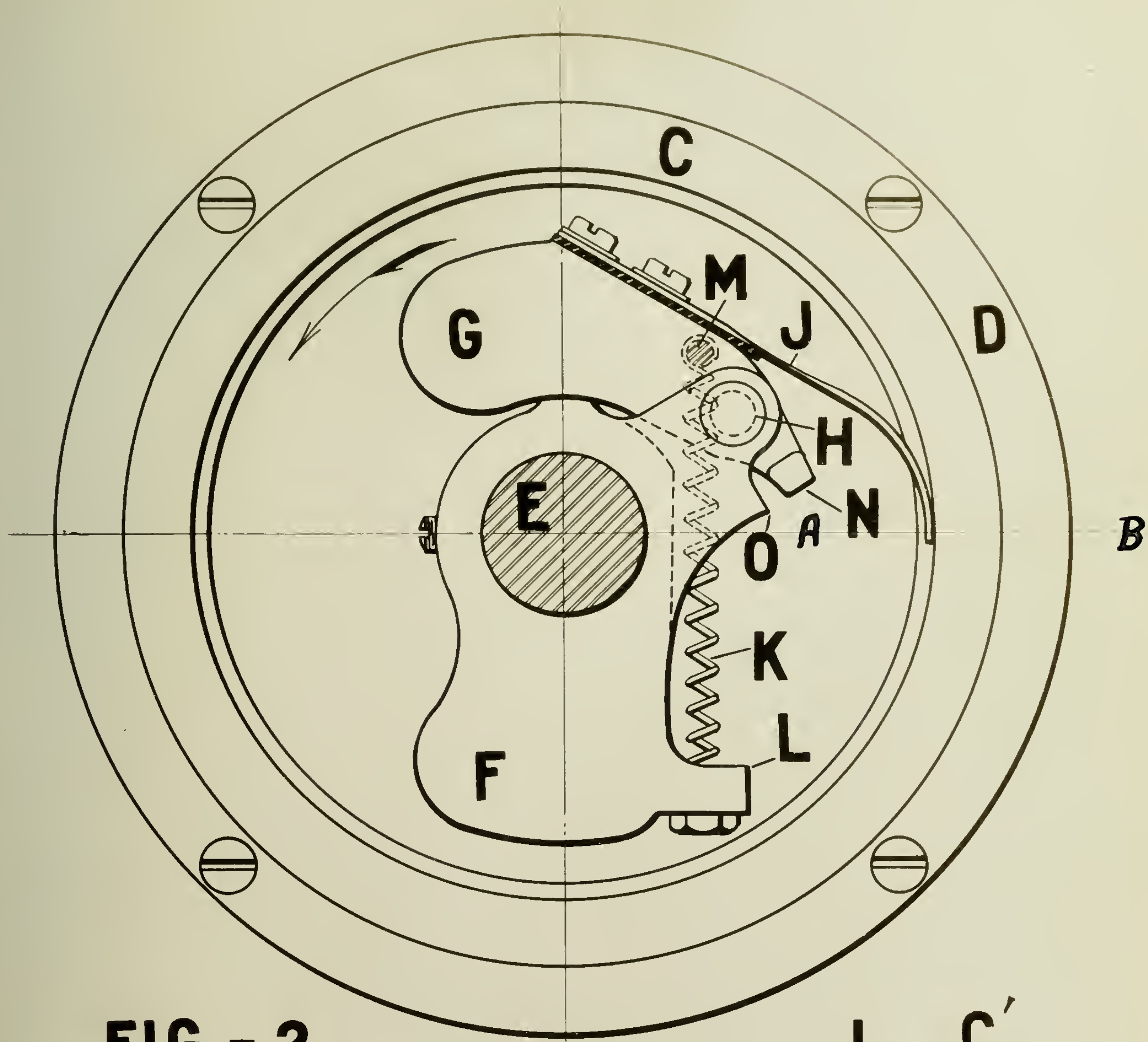

FIG.– 2

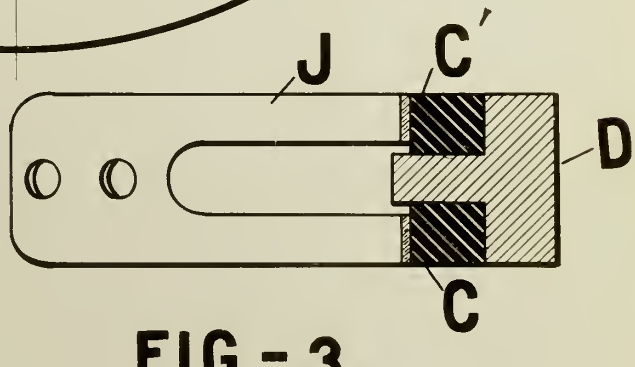

FIG.– 3

and as the square of the velocity, it follows that when G starts out that the governor is beyond isochronism or that the centrifugal force increases faster than the centripetal force and the weight G will stay out till a low speed is reached. When G has moved out to the running position it balances the counterweight F, so that the whole switch is in running balance. When G is all the way out, the lug N strikes O, preventing G from striking C or C'.

Arcing between the rings C C' and the brush J was anticipated, but starting and stopping automatically every thirty seconds for one week, a service equal to over ten years operation on a Linotype machine, showed no indication of pitting of either the phospher bronze brush or cast iron rings.

The regulation of the motor was perfect, and after testing the first machine for two hours, the Merganthaler Company ordered seventy-five motors for the earliest possible delivery.

PROBLEM XI.

PROBLEM
XI.

To provide a gas calorimeter for commercial work that can be manipulated by one person, which will permit of continuous operation, and in which the personal error of observation and manipulation is eliminated.

THE NECESSITY OF SUCH AN INSTRUMENT.

While conducting an efficiency test of a 100 B.H.P. Nash gas engine in the days when there were Junker gas calorimeters only, and but one in the City of Chicago, the author obtained the calorific value of natural gas from this instrument, manipulated by two students trained in such work. While the author was getting diagrams from the engine, inlet and outlet temperatures, water meter readings, revolutions of engine, volts and amperes, every five minutes, the calorific value of the gas could not be given me until the test was over.

Careful investigation disclosed the reasons for not being able to obtain continuous records, or at least twelve deductions per hour. The operators were accustomed to let calorimeter run for about thirty minutes, then stop testing and figure out the results. The instrument was graduated in the metric system, and one operator was accustomed to transform calories to B.t.u. while the other was taking readings. As the inlet thermometer was about two feet lower than the outlet thermometer, the operator either had to kneel each time he read the inlet temperature, or reading the mercury height from an angle, jeopardize the accuracy of the observation. Instead of weighing the outlet water, the temperature of which had been raised by the heat of combustion, and the volume of which varies with the temperature, it was measured in a graduated beaker in which the meniscus made the actual water level so indistinct that the observation of each operator would vary as much as a cubic centimeter.

Then again, hand manipulation of the overflow, from a beaker to the sink (continuous readings seemed impracticable) when a certain number of feet of gas had been burned, introduced a possible error through diagonal vision and slow action, all of which justified the elimination of as many personal equations as possible.

While natural gas was the fuel used, the demand for it was so great with a falling temperature, that to maintain the pressure it was reinforced at times by water gas, causing a drop in its calorific value of as much as 200 B.t.u. in a few hours.

While the only available gas calorimeter at that time might have been satisfactory for laboratory use, it would not fulfill the requirements in commercial testing, and to get an instrument which would comply with the author's idea it was necessary to design it along the following lines.

The values obtained should be in B.t.u. per cubic feet of gas, thereby eliminating the possible errors in converting metric measurements. The inlet and outlet thermometers should be on a level with the operator's eye to facilitate simultaneous reading, and to eliminate the "getting up" and "getting down" of the operator. The water should be weighed instead of measured. The outlet water should be switched automatically from one receptacle to another when a certain volume of gas has been burned, thereby not only providing for continuous operation, but also eliminating the personal error of hand manipulation and the necessary close observance and watchfulness of the position of meter needle when such shifting should take place. This duty alone requires the constant attention of one observer when determinations are desired.

In order to further minimize the calculations Fahrenheit thermometers are used which may be divided into tenths degrees, giving nearly twice as close a reading as can be obtained from a centigrade thermometer with tenth degree divisions, and the weighing scales should read in pounds and hundreths of pounds

Fig. 1

Fig. 2

to get accurate and quick results.

SOLUTION.

The solution of this problem is shown in Fig.1 and accompanying specification No.816042. The inlet and outlot thermometers aro on the same level and are graduated in tenths degrees Fahrenheit. The test meter (Fig.2) is divided into thousandths, one rotation of the needle passing one tenth of a cubic foot of gas.

This meter is supported on three adjustable legs instead of four, is leveled by a bull's eye level on top center, has a sight adjustment for water level, a filling funnel, the inlet and outlet gas pipes are on the rear, and a switch for disconnecting the electrical circuit while warming up calorimeter before readings are taken and recorded. This electrical contact made every rotation of the meter needle releases magnetically a catch on the water trough, permitting the weight of the water to rock the trough to a new position, and discharge for the next tenth of a foot of gas burned, the heated water into an empty bucket. While the second bucket is filling the weight of the water in the first is ascertained, which, multiplied by the difference between the inlet and outlet temperatures, gives the B.t.u. direct. With this instrument one operator can obtain continuous calorific values during a ten hour test, and can plot a curve showing the variations in heat values of the gas during the run. So practical are the improvements enumerated that today every modern calorimeter of this type uses all of them not protected by patents, i.e., the thermometers are on one level; the water is weighed on decimal scales and not measured, and unless specifically ordered, Fahrenheit thermometers are supplied.

Several hundred automatic calorimeters bearing the author's name are in constant operation, and according to reports of the Bureau of Weights and Measures, have no superior.

For more complete description of the advantages of this calorimeter see Article "The Testing of Inflammable Gases" Volume 28, Proceedings of the A.S.M.E.

No. 816,042. PATENTED MAR. 27, 1906.

C. E. SARGENT.

GAS CALORIMETER.

APPLICATION FILED SEPT. 8, 1905.

2 SHEETS—SHEET 1.

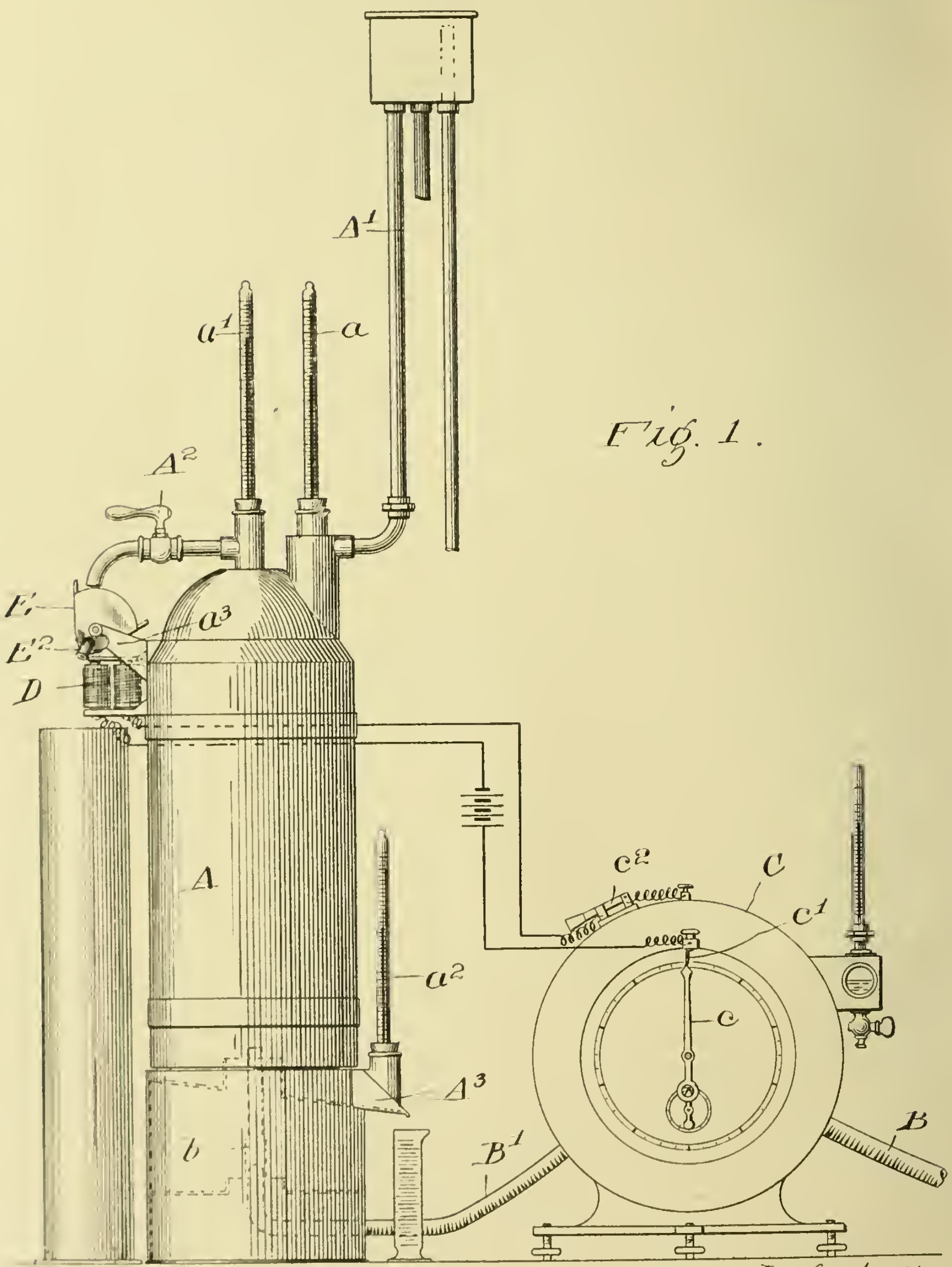

Fig. 1.

Witnesses
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Inventor:
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Attys

No. 816,042.

PATENTED MAR. 27, 1906.

C. E. SARGENT.

GAS CALORIMETER.

APPLICATION FILED SEPT. 8, 1905.

2 SHEETS—SHEET 2.

Fig. 2.

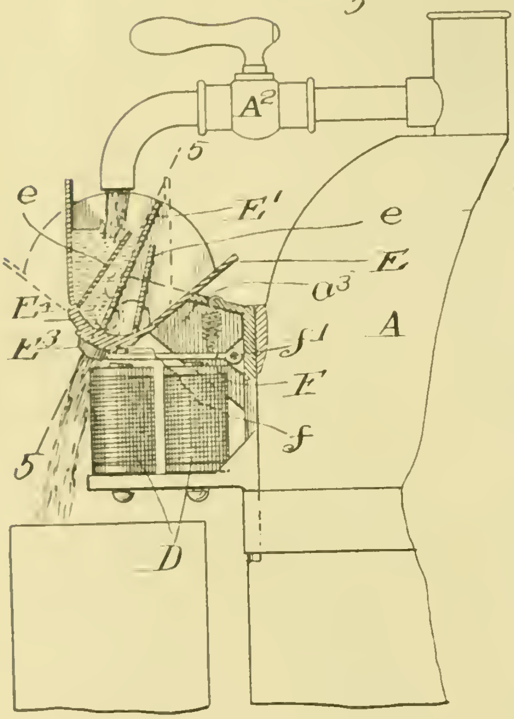


Fig. 3.

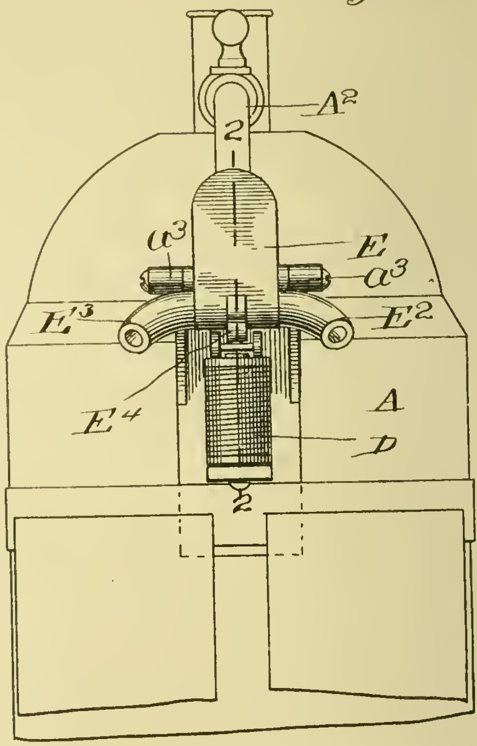


Fig. 4.

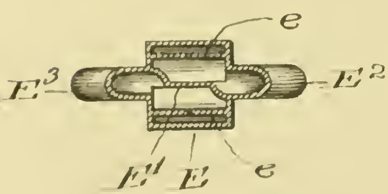
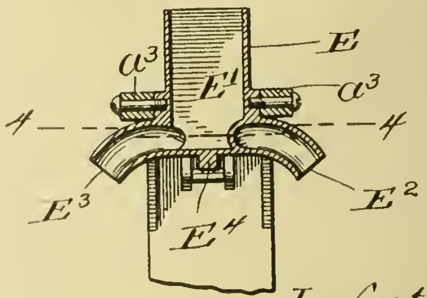


Fig. 5.



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UNITED STATES PATENT OFFICE.

CHARLES E. SARGENT, OF CHICAGO, ILLINOIS.

GAS-CALORIMETER.

No. 816,042. Specification of Letters Patent. Patented March 27, 1906.

Application filed September 8, 1905. Serial No. 277,572.

To all whom it may concern:

Be it known that I, CHARLES E. SARGENT, a citizen of the United States of America, residing at Chicago, in the county of Cook and State of Illinois, have invented certain new and useful Improvements in Gas-Calorimeters, of which the following is a specification.

My invention relates to improvements in gas-calorimeters, and is fully described and explained in this specification and shown in the accompanying drawings, in which—

Figure 1 is a side elevation of my improved device. Fig. 2 is a section in the line 2 2 of Fig. 3. Fig. 3 is a detailed front elevation of certain portions of my improved device. Fig. 4 is a section in the line 4 4 of Fig. 5, and Fig. 5 is a section in the line 5 5 of Fig. 2.

Referring to the drawings, A is the heater of my improved calorimeter, the same being of any ordinary form. The heater is supplied with water at a constant head by a feed-pipe A′ and has an outlet-faucet A^2 extending forward. The temperature of the water entering the heater A is shown by a thermometer a, and the temperature of the water leaving the heater is shown by a thermometer a'. The gas to be tested comes in from a pipe B, passes through a meter C, thence through a pipe B′ to a burner b. The water of condensation from the gas runs out at A^3, its temperature is measured by a thermometer a^2, and its quantity is measured in an ordinary glass graduate. The amount of this liquid is small and can be taken care of in this way; but this factor must be taken into account to obtain accurate readings.

The meter C has a needle c, which periodically comes in contact with an insulated contact-piece c' to close an electric circuit controlled by a switch c^2 and containing an electromagnet D.

The water flowing from the outlet-faucet A^2 enters a trough E, pivoted below its center of gravity between ears a^3 on the heater-body. This trough is divided longitudinally by a partition E′ into two portions, one of which is connected to a spout E^2 and the other of which is connected to a spout E^3, said spouts being at opposite ends of the trough. It will thus be seen that water in one of the portions of the trough will flow out at one end, while water in the other portion will flow out at the opposite end. Each of the trough portions is partially divided by a partition e, perforated at its lower end, the position and arrangement of this portion being clearly illustrated in Fig. 2. The trough E has on its bottom a stop E^4, which is adapted to be engaged upon either side by a pin f on an armature F, pivoted at f', said armature being in position to be operated by the electromagnet D referred to.

It will be seen that when the device is at rest and no water is passing through it the trough will lie on one side or the other of the vertical line passing through its pivot, and at such times the stop E^4 will be engaged by the pin on the armature to hold the trough in this position, which may be the position illustrated in solid lines in Fig. 2. Assuming now that it is desired to operate the apparatus, the gas is turned on, the flame lighted, and water is permitted to flow through the heater. The water on passing out from the heater will enter the uppermost trough-section and from there will flow out of one of the spouts E^2 E^3 into a suitable reservoir provided for the purpose. In starting the apparatus the switch c^2 will probably be opened, so that the water will flow in this way until the difference in temperature between the water entering and leaving the heater has reached a constant—*i. e.*, until the metal parts of the heater are warmed up sufficiently to remove any error due to what may be called "caloric inertia." Thereupon the switch c^2 will be closed, and thereafter the first time the hand c of the meter passes the contact c' the electric circuit will be completed, the magnet D energized, and the armature F attracted, thus drawing the pin f out of the path of the stop E^4. At this time it will be seen the uppermost portion of the trough is full of water, and consequently much heavier than the other, and the moment the pin on the armature is removed this section will move downward, causing the water from the heater to enter the other section, which has up to this time been idle. As soon as the needle has passed the contact c' the magnet will be deënergized and the armature will return to place, locking the trough in its new position. To hold the trough during the appreciable length of time that the needle is passing the contact and the trough consequently is free to move in either direction is the function of the partial partitions e. These partitions cause the water to flow out slowly and hold it in the highest portion of the trough and those portions farthest removed laterally from the trough-pivot. Thus when the trough swings from the position shown in solid lines to the position shown in dotted lines in Fig. 2 the water in the left-hand trough-section flows out slowly and until it has flowed out it is held in the upper and forward portion of the trough, and consequently exerts the greatest tilting effect possible on the trough. This body of water holds the trough in its new position until the water has decreased and the water in the other section has increased sufficiently to balance each other. This occupies quite a considerable length of time, and in the meanwhile the armature has returned to position, so that the trough is locked. It will be seen that the partitions c are sufficiently low that the normal flow of water passes over them. It is thus only immediately after the change in position of the trough that these partitions are of utility, and they then perform the very valuable function of detaining a portion of the water to act as a weight for a considerable period of time. It will be seen that when the trough is tilted, as above set forth, the water from the heater flows through the other section and out at the other end of the trough into a different reservoir. If it is desired only to measure the heating capacity of the gas passing through the meter during a single revolution of the needle, nothing more need be done, for when the needle completes its rotation it will again close the electric circuit and cause the flow to enter the first trough-section, and consequently be cut off from the receiving-reservoir. In this way one reservoir will catch the water passing through and heated in a single revolution of the needle and no more or less. Heretofore it has been customary to note the time when the needle passes a given point in the dial and then cut off the water-flow by hand or some other method equally affected by the personal equation of the operator has been adopted. With my device the personal equation is practically eliminated except in the reading of the thermometers, for the calorimeter itself deposits in a given receptacle the water which passes through it during the time when the burner is using a given volume of gas. If it is desired to make a longer reading than that of a single turn of the meter-needle, the switch c' can be opened shortly after the trough is shifted in one direction and can be closed after any given number of turns of the needle. Then when the switch is closed no result will take place until the needle completes a revolution, and the water in the reservoir will be exactly the amount which passed through the apparatus during the total movement of the needle.

I realize that considerable variation is possible in the details of this construction without departing from the spirit of the invention, and I therefore do not intend to limit myself to the specific form herein shown and described.

I claim as new and desire to secure by Letters Patent—

1. The combination with a heater, a fuel-meter and a source of water-supply connected with the heater, of a device for directing the flow of water to a reservoir and deflecting it therefrom, and means governed by the meter for controlling said device.

2. The combination with a heater, a fuel-meter and a source of water-supply connected with the heater, of a water-receptacle arranged to receive the flow from the heater and means under the control of the meter for directing the flow from said receptacle to a reservoir and deflecting it therefrom.

3. The combination with a heater, a fuel-meter and a source of water-supply connected with the heater, of a water-directing device which can occupy two positions said device being constructed and arranged to direct water in a different direction in each of its positions and means under the control of the meter for determining the position of said water-directing device.

4. The combination with a heater, a fuel-meter and a source of water-supply connected with the heater, of a pivoted water-receiving device which can occupy two positions and which is constructed and arranged to direct water in a different direction in each of its positions and which is constructed and arranged to move from one position to the other under the influence of the water and a stop for holding the receiving device against the influence of the water, and means governed by the meter for withdrawing the stop to permit the receiving device to move.

5. The combination with a heater, a fuel-meter and a source of water-supply connected with the heater, of a pivoted water-deflecting device capable of occupying two positions and constructed and arranged to move under the influence of the water which it contains at any given time, means under the control of the meter for preventing movement of the water-deflecting device except at certain times, and a device of retarding the movement of the water from the water-deflecting device after its movement.

6. The combination with a heater, a fuel-meter and a source of water-supply connected with the heater, of a pivoted water-deflecting device capable of occupying two positions and operating to cause water to flow in a different direction in each position and to be moved from one position to the other under the influence of the water it contains, a stop arranged to prevent movement of the water-deflecting device, an electromagnet arranged to withdraw the stop and an electric circuit including said magnet and controlled by the meter.

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7. The combination with a heater, a fuel-meter and a source of water-supply connected with the heater, of a pivoted trough divided into two portions and having a different opening from each portion, said trough being arranged to receive water from the heater in the portion which is uppermost at any given time and a stop controlled by the meter and engaging with the trough.

8. The combination with a heater, a fuel-meter and a source of water-supply connected with the heater, of a trough divided into two portions each of which has a separate opening, said trough being pivoted below its center in position to receive the water from said heater, a stop on said trough, and means of connection between the stop and the meter.

9. The combination with a heater, a fuel-meter and a source of water-supply connected with a heater, of a trough divided into two portions each of which has a separate opening, said trough being pivoted below its center in position to receive the water from said heater, a stop on said trough, and means of connection between the stop and the meter, and a partial partition in each trough-section arranged to hold a portion of the water in each section after the trough has shifted.

In witness whereof I have signed the above application for Letters Patent at Chicago, in the county of Cook and State of Illinois, this 29th day of August, A. D. 1905.

CHARLES E. SARGENT.

Witnesses:

CHAS. O. SHERVEY,

KATHLEEN CORNWALL.

PROBLEM XII.

PROBLEM
XII.

To build a self-adjusting universal air jack for barring over flywheels of gas or steam engines, enabling a man or boy to do the work of three or four men in one quarter of the time.

DEMANDS FOR SUCH A DEVICE.

The rotating and reciprocating parts of a modern horizontal tandem double-acting internal combustion gas engine weigh from 120 pounds to 150 pounds per B.H.P. These parts on a a 500 H.P. engine would weigh about 35 tons, and on a 4000 H.P. engine about 250 tons.

Should a single crank engine stop on center,or should it be necessary to set the valves,some method of barring engine over is necessary. This is usually accomplished by three or four men bearing down on the outer end of one or more crowbars, the ends of which are inserted in pockets cast on periphery of flywheel, near which is a fulcum over which the prying is done. When a flywheel alone weighs forty tons the inefficiency of auch a crude arrangement is apparent.

An improvement over the crowbar is a pawl operated by a long lever, which engages cast teeth somewhere on rim of flywheel, or band wheel (Fig.2) but even such a device requires the main strength of several men for engines above 500 H.P. Barring engines or electric motors are used in marine practice for turning over the propeller shafts, but in gas engine installations steam pressure is not available, and electric current only after engines have been started.

SOLUTION.

As all large internal combustion engines are started by compressed air, and as air under pressure is, or always should be available. an air jack (Fig.1)

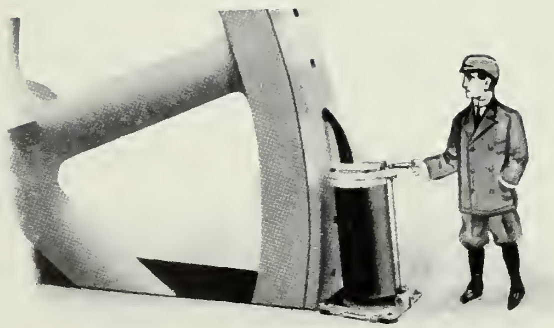


Fig. 1

was designed, by which one man or boy can turn the largest flywheel used in gas engine installations. It is good practice to carry an air pressure equal to the compression, which in blast furnace gas engines will run 175 pounds gage per square inch. An air jack having a ten inch piston, with 175 pounds air pressure will have a lifting force of over 6-3/4 tons, sufficient for all practical purposes.

Normally (see detailed specification No.935235) the piston is at bottom of cylinder, and the pawl is held away from the flywheel by the spring H.

To barr the flywheel over three-way cock D is turned by the handle E, allowing the air to enter the cylinder, which, acting first on piston I, moves the top of pawl against the flywheel and then raising the main piston and pawl until it engages one of the holes in flywheel, when the pressure of the air rotates the rim, a distance equal to the stroke of the piston; reversing the handle permits the air to escape from under the piston and the pawl to return to the bottom for another stroke.

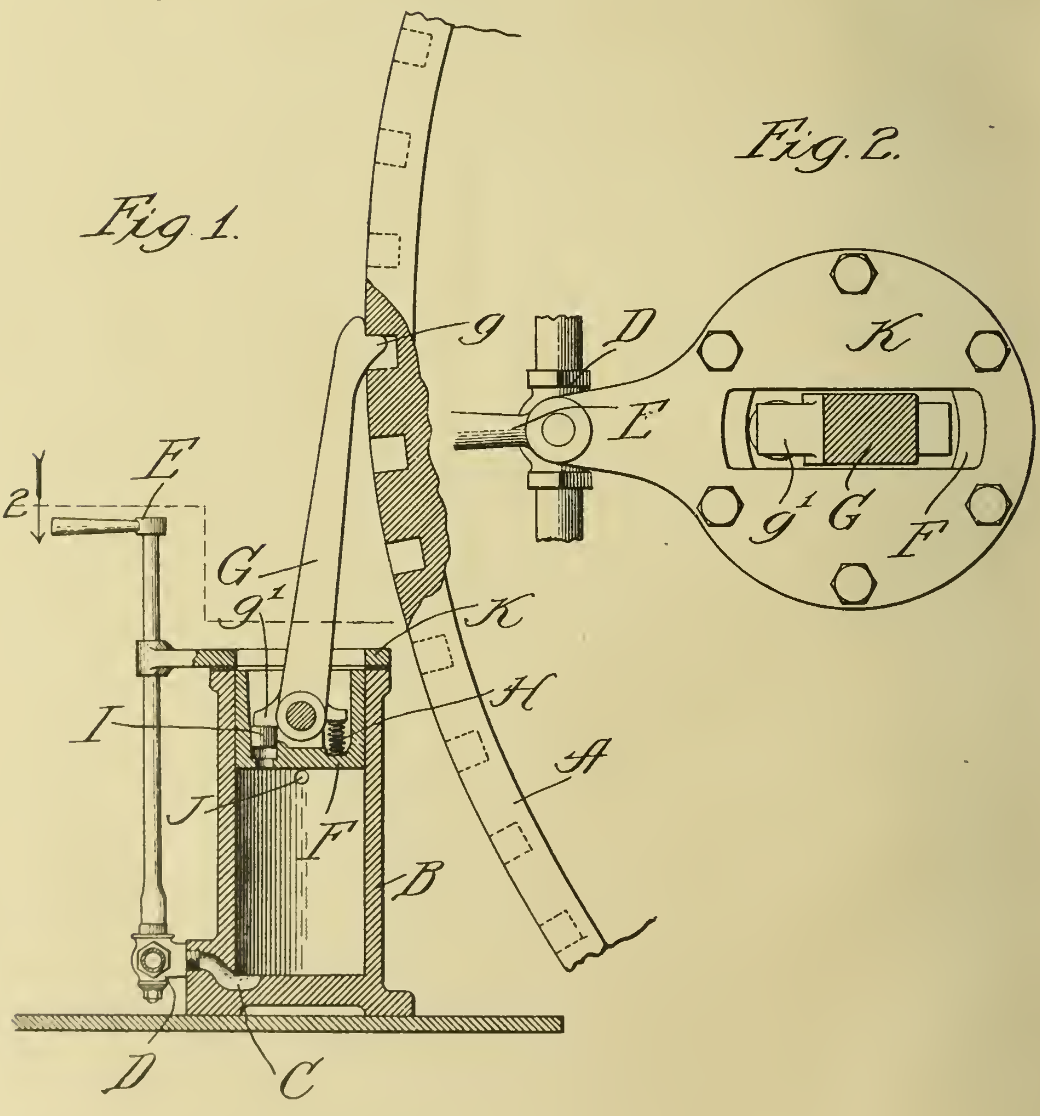
Fig.2

C. E. SARGENT.

DEVICE FOR BARRING OVER ENGINES

APPLICATION FILED JULY 18, 1908.

935,235. Patented Sept. 28, 1909.



Witnesses:
John Enders
Chas. H. Bull

Inventor:
Charles E. Sargent.
By Dyrenforth, Lee, Chritton & Wiles
Attys.

UNITED STATES PATENT OFFICE.

CHARLES E. SARGENT, OF CORLISS WISCONSIN, ASSIGNOR TO THE WISCONSIN ENGINE COMPANY, OF CORLISS, WISCONSIN, A CORPORATION OF WISCONSIN.

DEVICE FOR BARRING-OVER ENGINES.

935,235. Specification of Letters Patent. Patented Sept. 28, 1909.

Application filed July 18, 1908. Serial No. 444,182.

To all whom it may concern:

Be it known that I, CHARLES E. SARGENT, a citizen of the United States, residing at Corliss, in the county of Racine and State of Wisconsin, have invented a new and useful Improvement in Devices for Barring-Over Engines, of which the following is a specification.

My invention relates to certain new and useful improvements in a device for barring-over engines, and is fully described and explained in the specification and shown in the accompanying drawing, in which:

Figure 1 is a central longitudinal section through my improved device, and Fig. 2 is an enlarged plan view taken at line 2 on Fig. 1.

Referring to the drawing, A is a fly-wheel of an engine provided with the usual notches for the engagement of the means by which the engine is to be barred-over. Adjacent to the fly-wheel and upon the floor of the engine-room or other suitable support is mounted a cylinder B provided with an intake-port C, access to which is controlled by a three-way cock D which can be operated by means of a handle E. Vertically movable in the cylinder B is a piston F to which is pivoted a pawl G having a tooth *g* adapted to engage with the notches in the fly-wheel A. The pawl G is normally held out of engagement with the fly-wheel by means of a spring H mounted upon the piston F and engaging with a projecting finger on the pawl G. On the opposite side of the pivot of the pawl G to the piston F, the piston is perforated and in the perforation is a vertically movable pawl-operating piston I which is adapted to engage with a projecting finger g^1 on the pawl G. The cylinder B is provided with an exhaust-port J which is uncovered by the piston in its upward movement. The cylinder is surmounted by a cover K slotted for the passage of the pawl as illustrated.

The device is operated in the following manner: When the piston is in its lowered position the pawl will be out of engagement with the fly-wheel. If the cock D be then turned to the proper position, it will open communication between the port C and a supply of compressed fluid, preferably compressed air. The compressed air entering the cylinder will first force upward the pawl operating piston I, thereby swinging the pawl to the right, into engagement with the fly-wheel, whereupon its tooth *g* will engage one of the notches of the fly-wheel. The piston will then move upward, rotating the fly-wheel to the extent of its scope, which will be in practice the distance between two or three of the notches of the fly-wheel. When the piston reaches the upper limit of its movement, it will uncover the port J, relieving the pressure in the cylinder and thereby arresting the upward movement of the piston. Thereupon the cock can be turned to another position so as to throw the port C into communication with the atmosphere, whereupon the pawl will drop back to its original position and the piston will fall by gravity. The operation can then be repeated indefinitely and the fly-wheel turned over by slow degrees to any desired extent.

The apparatus is particularly desirable for use in connection with gas engines for the reason that all modern high power engines are provided with means whereby they can be started with compressed air and the supply of compressed air being always accessible the application of the device requires no special appliance. It is to be borne in mind that modern high power gas engines are so made that they must be barred-over to certain positions in order to be started with compressed air unless they are of the twin-tandem type and even twin-tandem engines frequently require to be barred-over for adjusting valves and similar operations. The device can, if desired, be applied to steam engines which often require to be barred-over for adjustment purposes and in many cases must be barred-over before they can be started.

I realize that considerable variation is possible in the details of construction of my improved device, without departing from the spirit of my invention, and I do not intend, therefore, to limit myself to the specific form herein shown and described.

What I claim as new, and desire to secure by Letters Patent, is—

1. The combination with a fly-wheel, of a barring-over device comprising a cylinder mounted adjacent thereto, a piston reciprocable in the cylinder, a port entering the cylinder, a hand-valve controlling the port and adapted by its operation to produce movement of the piston, and fly-wheel engaging

means movable with the piston and constructed and arranged to engage the fly-wheel while the piston is moving in one direction, and to be automatically disengaged therefrom when the piston is moving in the opposite direction.

2. The combination with a fly-wheel, of a barring-over device comprising a cylinder mounted adjacent thereto and provided with an intake port, a three-way hand-operated cock adapted to connect the cylinder alternately with a source of fluid under pressure and with the atmosphere, a piston reciprocable in the cylinder, and fly-wheel engaging means carried by the piston and constructed and arranged to engage the fly-wheel while the piston is moving under the influence of fluid pressure and to be automatically disengaged therefrom when the piston is moving in the opposite direction.

3. The combination with a fly-wheel, of a barring-over device comprising a cylinder mounted adjacent thereto, hand operated means for alternately admitting fluid under pressure to the cylinder and releasing the same therefrom, a piston movable in the cylinder and fly-wheel engaging means carried by the piston and constructed and arranged to automatically engage the fly-wheel when the piston is moving under the influence of fluid-pressure and to be automatically disengaged from the fly-wheel when the piston is moving in the opposite direction.

4. The combination with a fly-wheel, of a barring-over device comprising a cylinder mounted adjacent thereto, means for alternately admitting fluid under pressure to the cylinder and releasing it therefrom, a piston movable in the cylinder, fly-wheel engaging means carried by the piston, means for normally holding the engaging means out of engagement with the fly-wheel, and a device operated by the entrance of fluid under pressure to the cylinder for engaging said means with the fly-wheel.

5. The combination with a fly-wheel, of a barring-over device comprising a cylinder adjacent thereto, means for alternately admitting fluid under pressure thereto and releasing the same therefrom, a piston movable in the cylinder, a fly-wheel engaging device pivoted to the piston and normally out of engagement with the fly-wheel, and a supplemental piston carried by the main piston and constructed and arranged to cause engagement between the fly-wheel engaging device and the fly-wheel when fluid-pressure is admitted to the cylinder.

6. The combination with a fly-wheel, of a barring-over device comprising a cylinder adjacent thereto, means for admitting fluid under pressure to the cylinder and releasing the same alternately, a piston movable in the cylinder, a pawl pivoted to the piston and normally out of engagement with the fly-wheel and a pawl-operating piston movable in the main piston and adapted to engage the pawl to move the same against the fly-wheel when pressure is admitted to the cylinder.

7. The combination with a fly-wheel, of a barring-over device comprising a cylinder mounted adjacent thereto, means for alternately admitting fluid under pressure to the cylinder and releasing the same therefrom, a piston movable in the cylinder, an exhaust-port adapted to be uncovered by the piston near the end of its upward movement, a pawl pivoted to the piston and normally out of engagement with the fly-wheel and a pawl operating piston mounted in the main piston and arranged to engage the pawl to move the same against the fly-wheel when fluid under pressure is admitted to the cylinder.

CHARLES E. SARGENT.

In presence of—
K. M. Cornwall,
R. A. Schaefer.

PROBLEM X111.

PROBLEM
XIII.

To make a thermostat for a fireless electrically heated cooker which will automatically open the circuit when a predetermined temperature is reached, which will not oxidize, corrode or deteriorate with use.

REASON FOR ITS INVENTION.

The efficiency of a fireless cooker in which the heating element or food is raised to a high temperature over a gas, electric or ordinary heating stove and then transferred through the air to a cold cooker, can be greatly increased by generating the heat in the cooker, thereby saving the heat lost by radiation and convection. As there are no products of combustion from electric heat, it seems the rational way to raise the temperature of a cooker, especially as current is getting cheaper every day, and when generated in an insulated receptacle but comparatively few watts are required.

As the fundamental idea of a fireless cooker is to hold the heat and cook with the original heat which necessarily gradually diminishes, there would be a risk in heating the cooker and contents electrically without some safety device which would open the circuit when some predetermined temperature is reached. On account of the steam and vapor from the contents attacking and oxidizing metallic thermostats (the heating element is separated from the cooking receptacle) such devices have not been a success.

The characteristics of dry air are such that for a thermometer or thermostat it has no equal. It expands in proportion to the rise in temperature, and on account of its very high coefficient of expansion, has the capacity for doing work even if confined not in, but in the neighborhood of the intense heat, therefore the capacity of cooker is not decreased.

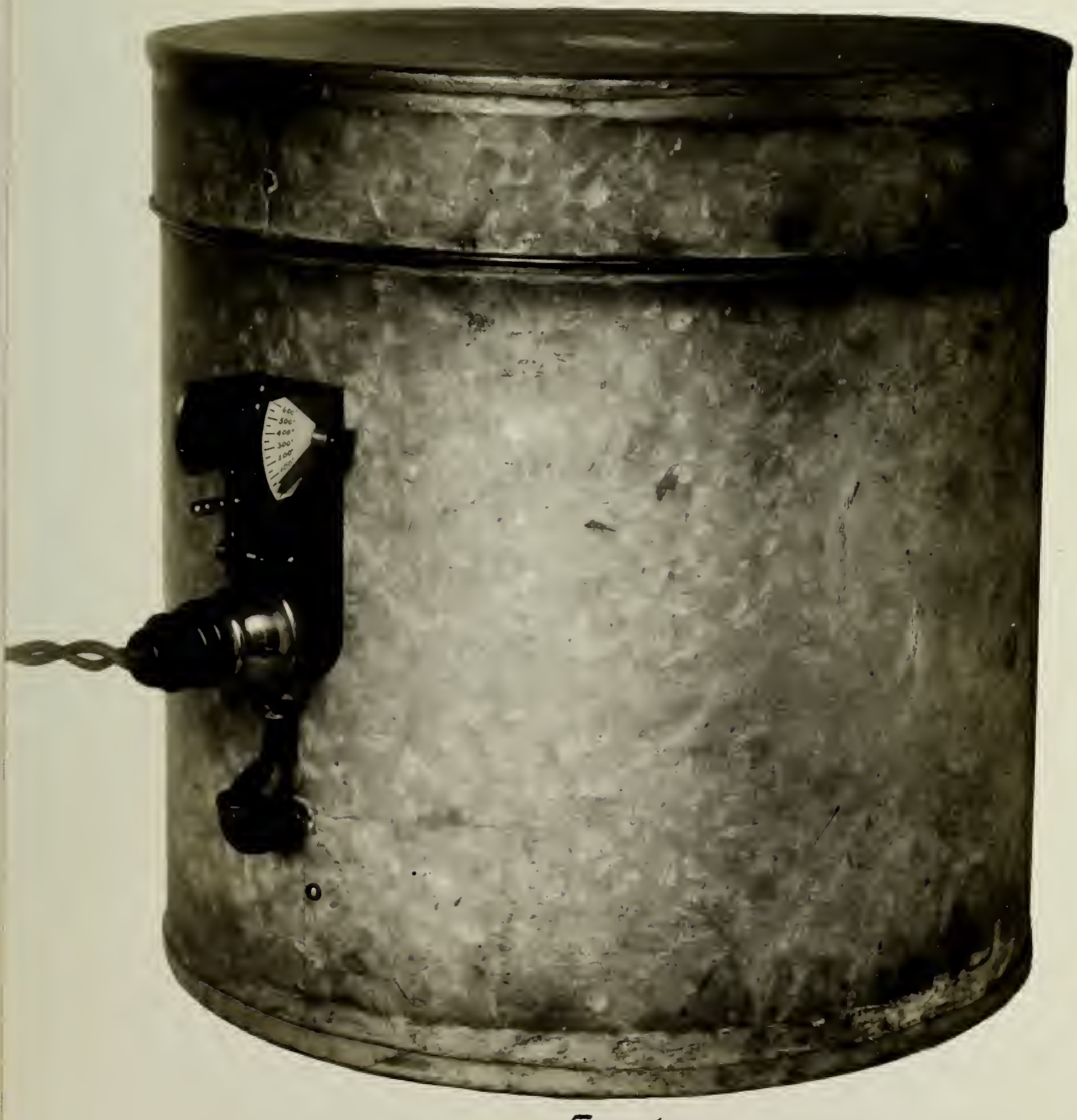


Fig.1

SOLUTION.

Such a thermostat is shown mounted on the side of a cooker (Fig.1) and on the cover of a "fireless cooker" (Fig.2) and in accompanying description No.1072170.

By adjusting the indicator any temperature may be obtained before the circuit is automatically opened.

Fig.2

C. E. SARGENT.

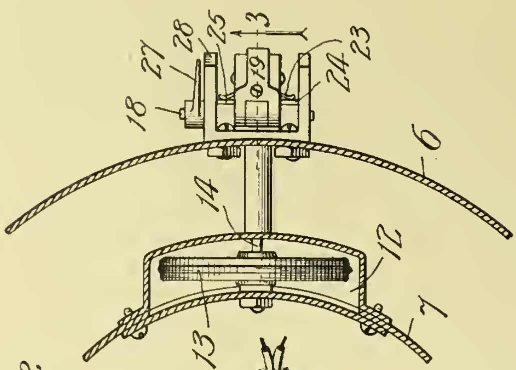
ELECTRIC COOKING DEVICE.

APPLICATION FILED MAY 20, 1911.

1,072,170. Patented Sept. 2, 1913.

2 SHEETS—SHEET 1.

Fig. 2.



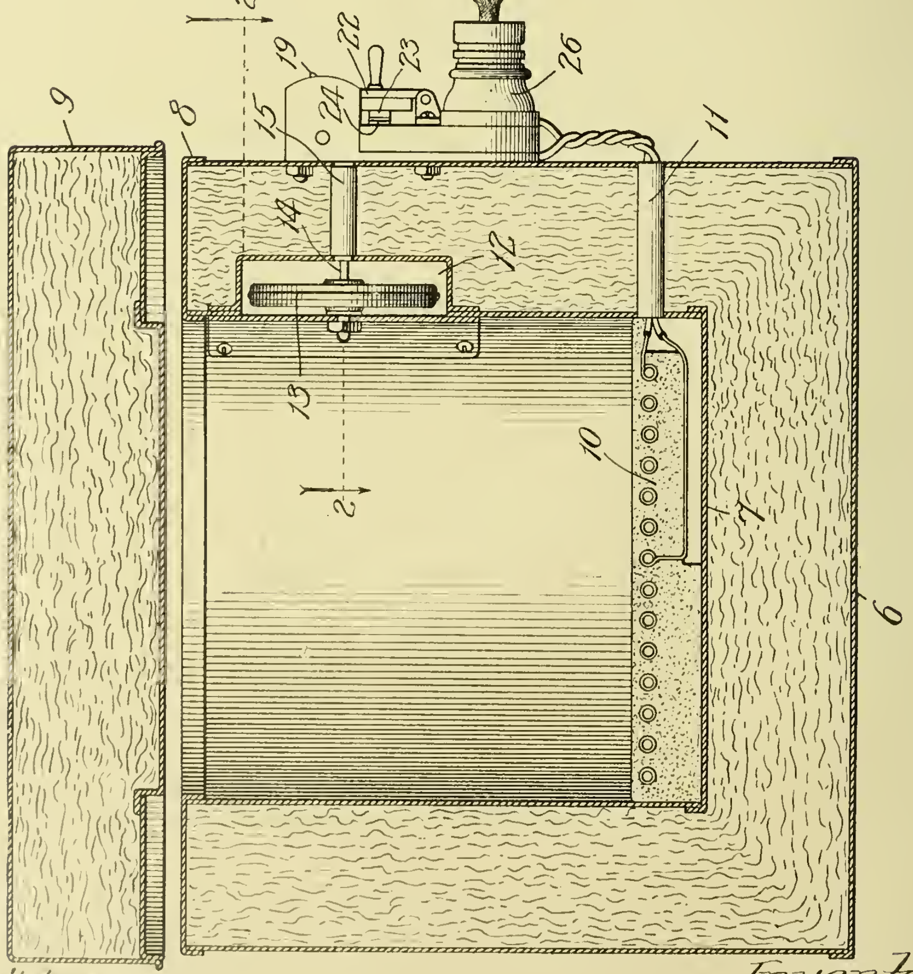


Fig. 1.

Witnesses:
Thos. E. Taylor.
G. F. Chase.

Inventor:
Charles E. Sargent,
By Dyrenforth, Lee, Chritton & Wiles,
Att'ys.

C. E. SARGENT.

ELECTRIC COOKING DEVICE.

APPLICATION FILED MAY 20, 1911.

1,072,170.

Patented Sept. 2, 1913.

2 SHEETS—SHEET 2.

Fig.5.

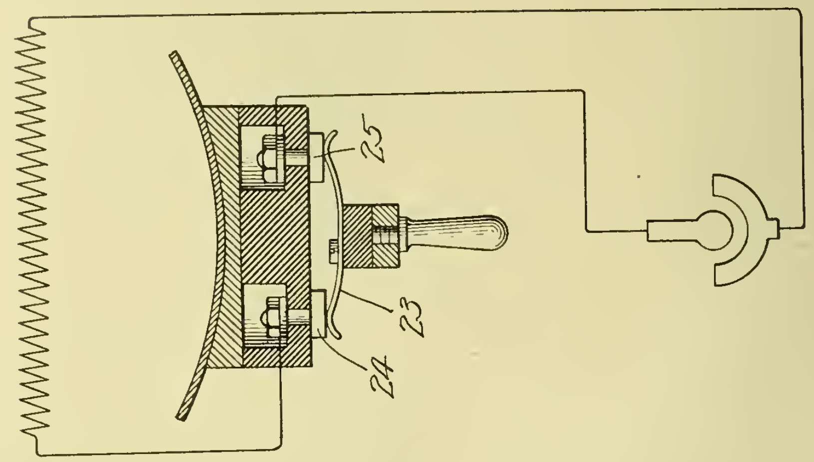


Fig.4.

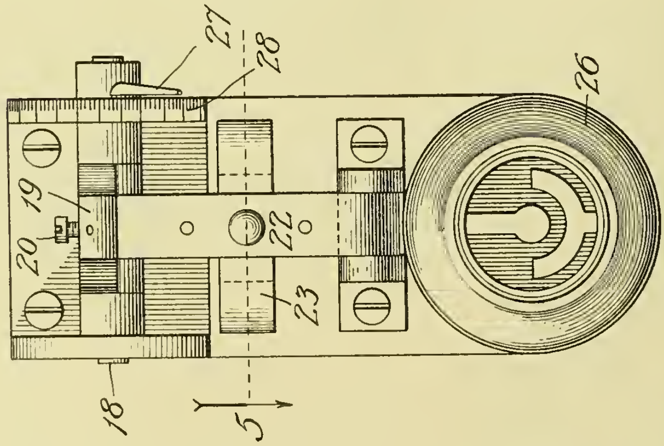
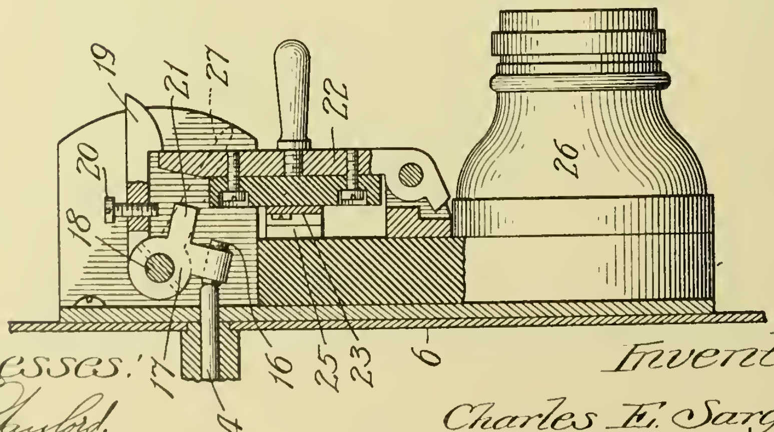


Fig.3.



Witnesses:

C. E. Gaylord.

G. F. Chase

Inventor:

Charles E. Sargent,

By Dyrenforth, Lee, Chritton & Wiles,

Attys.

UNITED STATES PATENT OFFICE.

CHARLES E. SARGENT, OF CHICAGO, ILLINOIS.

ELECTRIC COOKING DEVICE.

1,072,170. Specification of Letters Patent. Patented Sept. 2, 1913.

Application filed May 20, 1911. Serial No. 628,442.

To all whom it may concern:

Be it known that I, CHARLES E. SARGENT, a citizen of the United States, residing at Chicago, in the county of Cook and State of Illinois, have invented a new and useful Improvement in Electric Cooking Devices, of which the following is a specification.

My invention relates to certain new and useful improvements in electric cooking devices, and is fully described and explained in the specification and shown in the accompanying drawings, in which:

Figure 1 is a vertical section through my improved device; Fig. 2 is a horizontal section on the broken line 2 of Fig. 1; Fig. 3 is a radial section on the line 3 of Fig. 2; Fig. 4 is an elevation of the switch mechanism and Fig. 5 is a diagrammatic view of the circuit.

Referring to the drawings, 6 is the outer and 7 is the inner wall of a double walled case or cooker proper, the two walls being insulated by a suitable insulating material, such as mineral wool or the like, and connected at the top by an annulus 8, in accordance with common practice in fireless cooking constructions.

9 is a cover of metal fitting tightly to the lower section and provided with a suitable insulation in accordance with common practice.

10 is an electrical heating element placed at the bottom of the cooker proper, as illustrated. This heating element may be of any desired form common in the art, its particular arrangement having no bearing upon my present invention.

11 is a tube connecting the inner and outer walls of the cooker and affording a passageway for the electric-wires which supply current to the heating element.

Between the walls of the cooker proper is a chamber 12 lying well within the outer wall so as to be thoroughly insulated from the outside air and in position to be affected by the heat in the cooker proper by conduction through the inner wall. This chamber 12 contains a hollow expansible air-diaphragm 13, one wall of which is attached to the inner wall 7 of the cooker and the opposite wall of which carries a pin 14 which extends outward through a tube 15 to the outside of the cooker. The outer end of the pin 14 is adapted, as it moves outward, to engage a screw on an arm 16 of a bell-crank lever 17 pivoted on a pin 18. Upon the same pin is pivoted a hook 19 carrying an adjusting screw 20, which is adapted to be engaged by an arm 21 on the bell-crank lever 17 as the same is moved. The outer end of the hook 19 engages the upper end of a switch-lever 22 carrying a contact piece 23 adapted to engage two contact plates 24 and 25. The contact plate 24 is connected to one end of the heating element and the other end of the heating element is connected to one terminal of a socket 26. The contact plate 25 is connected, as illustrated in Fig. 5, with the other terminal of the socket 26. Thus, when the socket is wired to a source of electric current and the switch-lever 22 is elevated so that the contact piece 23 connects the contacts 24 and 25, the current will flow through the heating element in an obvious manner. As the temperature inside of the cooker rises, the air-diaphragm 13 will expand forcing the pin 14 outward and rotating the bell-crank lever 17 on its axis so that the arm 21 will presently engage the screw 20 of the hook 19, freeing the same from the end of the switch-lever 22 so that the natural elasticity of the contact piece 23 assisted by gravity will cause the switch-lever to swing downward, breaking the circuit.

The apparatus is set so that it will automatically break its circuit at any desired point in the following manner. The spindle of the bell-crank lever 17 carries an indicating needle 27, which coöperates with a temperature scale 28. In setting the device, this needle is moved by hand to that point where it is desired to have the further flow of current cease. While holding the indicating needle in this position the screw 20 is adjusted by screwing it downward until the switch-lever is freed from the hook. The material to be cooked is then placed in the cooker and the cover placed in position, and the bell-crank lever and indicating needle are permitted to fall to their normal positions. As the air-diaphragm expands and the pin 14 moves outward, rotating the bell-crank lever, the hook will obviously release the switch-lever at just that point determined by the previous adjustment. In this way it is made perfectly certain that the flow of current will be cut off at the proper temperature and there is no danger that the contents of the cooker will be cooked too much.

I am aware that it has heretofore been proposed to build inclosed cookers with an electric heating element, and that efforts have been made to incorporate a thermostatic device for cutting off the flow of current when the temperature within the cooker has reached the desired point. There are, however, conditions of a peculiar nature surrounding devices of this character which make the present form of thermostatic device substantially the only practical device for the purpose. The device must be capable of a very wide range of adjustment, different foods requiring temperatures varying to enormous extents. The device must be compact. Any device which must necessarily cross the cooking space is absolutely out of the question because the food could not be placed in and removed from the cooker with such a device in use. The device must be wholly concealed and protected from the deleterious effects of food which may be spilled upon it. It must be simple, absolutely unfailing in its action and capable of adjustments by those wholly unversed in mechanics. These various problems and requirements make it impossible to select any ordinary thermostatic device in use and apply it to a device of this character, but on the contrary as far as I am aware, they make the present thermostatic device broadly considered the only practical type.

I am aware that considerable variation is possible in the details of the mechanical construction here set forth, without departing from the spirit of my invention and I therefore, although I have fully described the present form in detail, do not intend to be limited thereto, except as pointed out in the following claims in which it is my intention to claim all the novelty of the present device as broadly as the state of the art will permit.

I claim as new and desire to secure by Letters Patent—

1. In combination, insulating walls inclosing a cooking chamber, an electrical-heating element within the cooking chamber, a recess in one of the walls of the chamber, a hollow gas-containing box in said recess and exposed to the heat within the chamber and insulated from the atmosphere, an electrical-switch and connections between one wall of the box and a switch for opening the same.

2. In combination, insulating walls inclosing a cooking chamber, an electrical-heating element for supplying heat to the chamber, an electrical-switch device controlling the flow of current through said heating element, a hollow gas-containing box having one wall fixed in position in a recess in one of the chamber-walls and exposed to the heat within the chamber and insulated from the atmosphere and connections between another wall of the hollow gas-containing box and the electrical-switch device.

3. In combination, insulating walls inclosing a cooking chamber, an electrical-heating element for supplying heat to the chamber, an electrical-switch device for controlling the flow of current through said heating element, a hollow gas-containing box having one wall fixed in position in a recess in one of the chamber-walls and exposed to the heat within the chamber and insulated from the atmosphere, and adjustable connections between another wall of the hollow gas-containing box and the electrical-switch device.

4. In combination, insulating walls inclosing a cooking chamber, an electrical-heating element for supplying heat to the chamber, a hollow gas-containing box supported in a recess in one of the walls and having a thrust-rod extending from one of its walls without the chamber, an electrical-switch device, a latch for holding this switch device normally closed, and connections between the thrust-rod and the latch.

5. In combination, insulating walls inclosing a cooking chamber, an electrical-heating element for supplying heat to the chamber, a hollow gas-containing box supported in a recess in one of the walls and having a thrust-rod extending from one of its walls without the chamber, an electrical switch device, a latch for holding the switch-device normally closed, and adjustable connections between the thrust-rod and the latch.

6. In combination, insulating walls inclosing a cooking chamber, an electrical-heating element for supplying heat to the chamber, a hollow gas-containing box supported in a recess in one of the walls and having a thrust rod extending from one of its walls without the chamber, an electrical-switch device, a latch for holding the switch-device normally closed, a bell-crank lever contacted by the thrust-rod and an adjusting screw on the latch to be struck by the bell-crank lever in its movement for the purpose set forth.

In testimony whereof I hereunto set my hand this 5th day of May, 1911.

CHARLES E. SARGENT.

In the presence of two subscribing witnesses:

J. G. Anderson,
R. A. Schaefer.

PROBLEM XIV.

PROBLEM
XLV.

To have a portable unbreakable, unspillable, draft-gage with a six inch range which can be read to one hundredth of an inch to go with testing outfit.

WHY NECESSARY.

The ordinary draft gage used in testing chimney draft, gas and air pressures is a U tube of glass fastened to an adjustable scale reading in tenth inches. Water in both legs stands at zero on the scale. When one leg of the U tube is connected to the chimney or gas pipe the difference between atmospheric pressure and the pressure in chimney or gas pipe is equal to the difference in level of the liquid in the two legs of the U tube. To read this pressure, the distance the liquid is above and below zero must be added together. If the pressure varies, which is often the case, it is practically impossible to note both readings at the same time, therefore errors are unavoidable. When the pressure changes the liquid goes up in one leg and down in the other, changing the shape of the meniscus, introducing more errors. The only difference between pressure and vacuum depends on which leg is connected to the chimney or gas pipe. As either pressure above or below atmospheric causes a difference in the level of the liquid in the two legs, the observer is liable to mistake vacuum for pressure, and in case of producer gas mains, permit of possible explosions.

To overcome the objection of a double reading, and at the same time permit of reading to one-hundredths inches, a liquid well and an inclined tube are used. When such an instrument is dead level an accurate reading to one-hundredth inches is possible, but if a range of more than three-quarter inches either way is desirable, the instrument is too long, too breakable and too unwieldly for portable use.

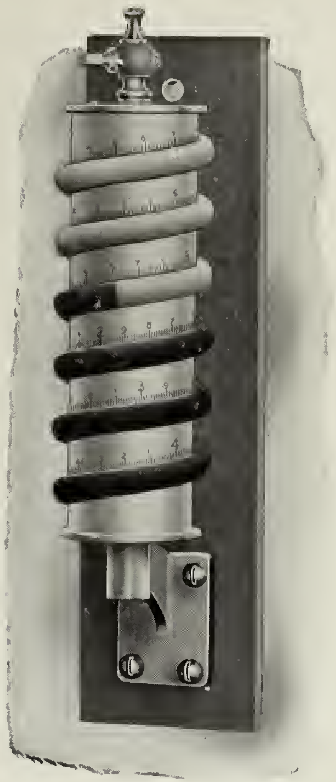


Fig.1

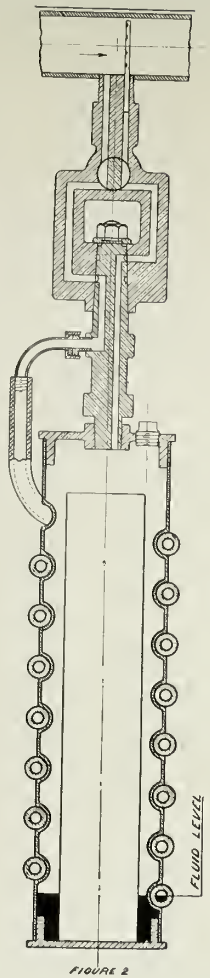


Fig.2

Fig.3

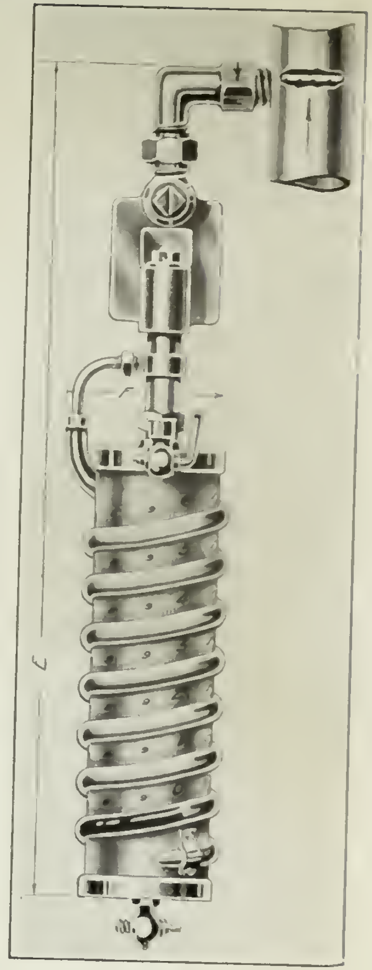


Fig 4

SOLUTION.

To solve this problem there is fastened to a gage board or bracket (Fig.1; specification No.841454) upon which is mounted a revolvable cylinder closed at the bottom and at the top by a hose cock, around which is wound in a spun helical groove a transparent celluloid tube, the lower end of which is connected with the bottom of cylinder. As the ratio between the area of well and the tube is such that one revolution of the liquid in tube means a difference of one inch pressure, and as the distance around the well is graduated in one hundred divisions, the pressure either below or above atmosphere, or zero, can be read in one hundredths inches.

To use the gage the well is filled with water to the zero mark, midway between bottom and top. Gage is hung up and the well is rotated to three positions 120° apart. If the meniscus, the top of which is parallel to the graduations (see Fig.1), comes to the same point in the three positions, gage is level and readings will be accurate.

Both openings may be closed and the gage carried in a grip without danger of breaking or leaking.

By connecting the well and top outlet of helical tube to Pitot tubes (Figs.2,3 & 4) the velocity of air or gas flowing through a pipe, irrespective of its statical head, may be accurately determined.

No. 841,454.

PATENTED JAN. 15, 1907.

C. E. SARGENT.

PRESSURE GAGE.

APPLICATION FILED NOV. 3, 1904.

Fig. 1.

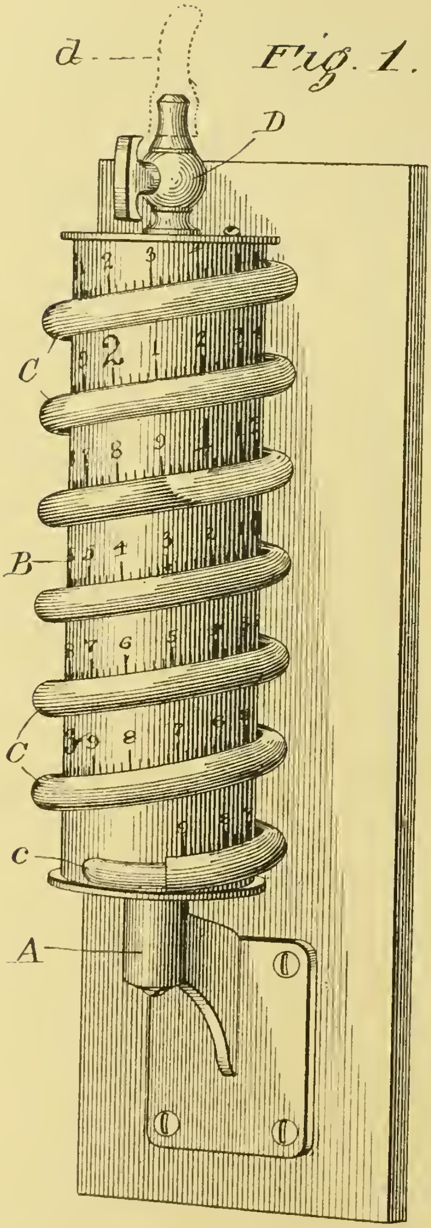
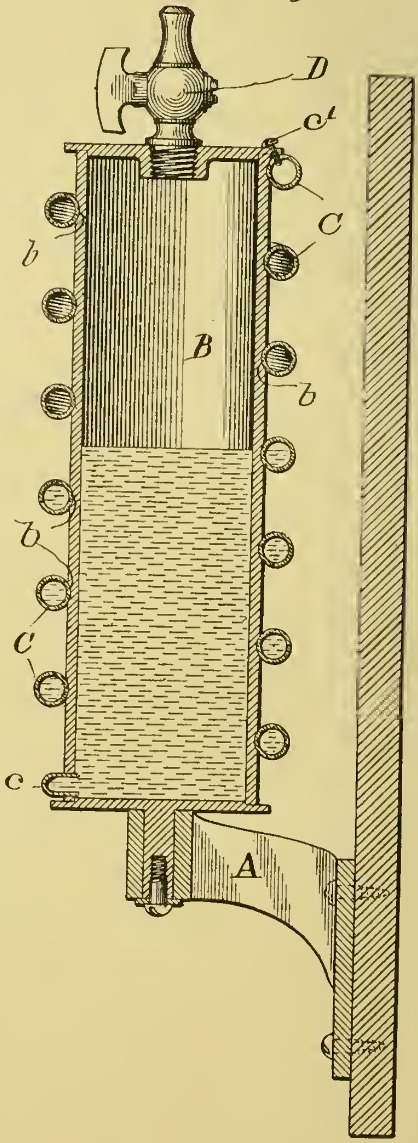


Fig. 2.



Witnesses:

K. M. Cornwall

J. E. Sherrey.

Inventor:

Charles E. Sargent,

by Bitun, Wiles & Sherwey

Attys.

UNITED STATES PATENT OFFICE.

CHARLES E. SARGENT, OF CHICAGO, ILLINOIS.

PRESSURE-GAGE.

No. 841,454. Specification of Letters Patent. Patented Jan. 15, 1907.

Application filed November 3, 1904. Serial No. 231,192.

To all whom it may concern:

Be it known that I, Charles E. Sargent, a citizen of the United States of America, residing at Chicago, in the county of Cook and State of Illinois, have invented certain new and useful Improvements in Pressure-Gages, of which the following is a specification.

My invention relates to certain new and useful improvements in pressure-gages; and its object is to produce a device of this class which shall have certain advantages, which will appear more fully and at large in the course of this specification.

To this end my invention consists in certain novel features, which are shown in the accompanying drawings as embodied in my preferred form of construction.

In the aforesaid drawings, Figure 1 is a perspective view of my improved pressure-gage, and Fig. 2 is a central vertical section through the same.

Referring to the drawings, A is a bracket at the end of which is journaled a vertical cylinder B. About the cylinder B is wrapped a spiral tube C, of some transparent or translucent material, preferably celluloid or the like. The tube C is connected at its lower end by a short metal tube *c* with the interior of the cylinder B and at its upper end is open to the air. The tube C is held in place by a screw *c'*. At the upper end of the cylinder is a cock D, shaped to receive the end of a rubber or other flexible tube, (shown in dotted lines at *d* of Fig. 1.) Except for the cock D and the opening into the tube the cylinder B is entirely closed.

The outer face of the cylinder B is marked in scale-divisions, the scale running along above the turns of the tube C. The scale is laid out by calibration, as will hereinafter be explained. The zero of the scale, it will be seen, lies approximately at the middle of the cylinder and the divisions are numbered in both directions therefrom.

My improved pressure-gage is adapted for measuring very light pressures or very slight vacua, and it is particularly designed for a draft-gage to measure the pressure in a chimney.

In operation water or other liquid, which may be colored or not, as is desired, is poured into the cylinder until it rises in the spiral tube to zero of the scale. The tube lies at such an angle that water or similar liquid forms a practically vertical meniscus at the upper side of the tube, which affords a very satisfactory indicating-point. When no pressure exists, this meniscus should lie opposite the zero of the scale. The top of the gage is then connected by a tube with the body of vapor whose pressure it is desired to measure and the cock is opened. The increase or decrease of pressure on the water in the cylinder will cause the water to rise or fall in the spiral tube, and the amount of pressure or vacuum can be read in inches of water and fractions thereof on the scale. The scale is laid off in the first instance by applying known pressures to the liquid in the cylinder and laying off the scale therefrom.

It will be obvious that the length of the scale-divisions will depend on the relative sizes of the cylinder and tube, for the ultimate indication depends not upon the absolute rise in the tube, but upon the level in the tube as compared with the level in the cylinder. Of course after a single scale has been laid off any number of devices of the same size can be made by copying the scale on the first device.

My draft-gage is particularly desirable in that it is very compact and easy to read, and in addition the length of tube used to indicate a short rise or fall of the liquid is so great as to make extremely accurate reading possible. The inclination of the tube and the surface tension of the water give a vertical meniscus which assists in the accuracy of the readings. The cylinder is made rotatable, so that all sides of it are readily accessible, and this is the most convenient arrangement, for the device when so constructed can be mounted upon a wall. In any case the rotatable mounting is probably more desirable, although it will be obvious that an operative and perhaps a commercially successful device can be made without this feature.

It should be noticed that the cylinder B is provided with a spiral groove *b* extending around it and adapted to form a seat for the spiral tube C. This arrangement insures the proper positioning of the tube and avoids any chance of its becoming displaced.

I realize that considerable variation is possible in the details of this construction without departing from the spirit of the invention, and I therefore do not intend to limit myself to the specific form herein shown and described.

I claim as new and desire to secure by Letters Patent—

The combination with a bracket, a cylindrical reservoir rotatably secured thereto, said reservoir having an opening at its upper end adapted to be put in communication with the vapor whose pressure is to be measured and a body of liquid within the reservoir, of a tube wound spirally about the reservoir, said tube opening at its lower end at the bottom of the reservoir and having its upper end open to the air.

In witness whereof I have signed the above application for Letters Patent, at Chicago, in the county of Cook and State of Illinois, this 22d day of October, A. D. 1904.

CHARLES E. SARGENT.

Witnesses:

CHAS. O. SHERVEY,

K. M. CORNWALL.

PROBLEM XV.

PROBLEM
XV.

To construct a variable speed transmission by which the driver at a constant speed can drive the driven member either direction from no revolutions per minute to its maximum speed, without end thrust, side thrust or short leverage at low speed and maximum power, which are indigenous to the ordinary friction drive.

ITS ORIGIN.

When electric blue printing machines of the cylindrical glass type through which an electric light travels were first developed, the author was requested to design a device which would lower a lamp at any predetermined speed, or about eight feet in from thirty seconds to thirty minutes - a ratio of sixty to one. At that time some of the sensitized papers required the long time exposure, and in order to make the machine thoroughly universal the above limits were demanded. As electricity was necessary to operate the lamp, and as the lamp had to return to the top of the machine after passing through the cylinder, and as it was usually necessary to switch out the light when ascending, the author's desire and suggestion was to provide a device which would eliminate the work of the operator by doing everything except feeding the paper and closing the switch, when the lamp would light and start on its downward journey.

The problem of permitting an arc lamp to descend at a uniform velocity, eight feet in half a minute, sixty times slower or any intermediate velocity seemed more difficult as the investigation progressed.

SOLUTION.

The final design, however, fulfilled the requirements laid down, but for commercial reasons was never put on the market. The method of getting any speed forward or reverse was obtained from mechanism illustrated in the accompanying specification No.751564.

The driving disc C, driven by an electric motor or engine runs at a constant speed in one direction. On both sides of the disc and diametrically opposite each other are four friction wheels (d,e,f,g) held against the driving disc by springs (xx). The two friction wheels d & e on the outside face of the friction disc are connected together through the bevel gears d^2 and e^2, and bevel pinions n n. These bevel pinions are carried on studs at right angles and keyed to the shaft h, upon which the hollow shafts d' and e' and the friction wheels d and e and gears d^2 and e^2 rotate. When friction wheels eg and dh are the same distance from the center of the driving disc, it is evident that all friction wheels will run the same speed, irrespective of the speed of the driving disc, and that the friction wheels diametrically opposite each other, but on the same side of driving disc, will run in opposite directions. It is also evident that if the two bevel gears d^2 and e^2 run in opposite directions and at the same speed that the bevel pinions n n will rotate around their shafts, but will not rotate the shaft h to which their shafts are keyed.

Now if the driven member is moved in relation to the driving member so that the center of the driving shaft is closer to one pair of friction wheels than the other, the pair further from the center will rotate faster than the pair closer to the center, therefore the pinions n n and their shafts will rotate driving the shaft h and pulley q at a speed equal to half the difference in velocity of the diametrically opposite friction wheels, and in the direction the farther friction wheel on the same side of driving disc as shaft h is revolving.

If we let

D = diameter of path of one pair of friction wheels

D'= " " " " other pair of friction wheels

d = diameter of friction wheel

R = Revolutions of driver

t = the R.P.M. of shaft h

then $t = \frac{R(D-D')}{2d}$

Now if for example $\frac{D+D'}{2} = 10''$, d equals 5" and R equals 500 R.P.M., it will be seen that if the center of the carriage carrying the friction wheels is moved one hundredth of an inch, the shaft h will have a velocity of one R.P.M., and that if the center is shifted six tenths of an inch, the shaft will have a velocity of 60 R.P.M., which meets one of the requirements of the problem.

One of the disadvantages of an ordinary friction drive is the end thrust and bending moment on the friction disc, both of which are eliminated in the above device.

To get low speed and great power in the ordinary friction drive the driven wheel is moved close to the center where the speed is low. In the author's device the greatest power is obtained and the slowest speed of driven shaft when both friction wheels run very nearly the same speed, and normally about twice the speed of driver. In the ordinary friction drive there is but one contact between driver and driven member, while in the author's there are four friction surfaces.

While this device for reasons stated was never sold for the purpose for which it was conceived, its application to a well boring machine where the auger had to be fed very slowly in rock and faster in sand and soft earth, and

reversed and raised quickly, made a successful machine out of a failure, and no doubt there are many places where the principle could be utilized.

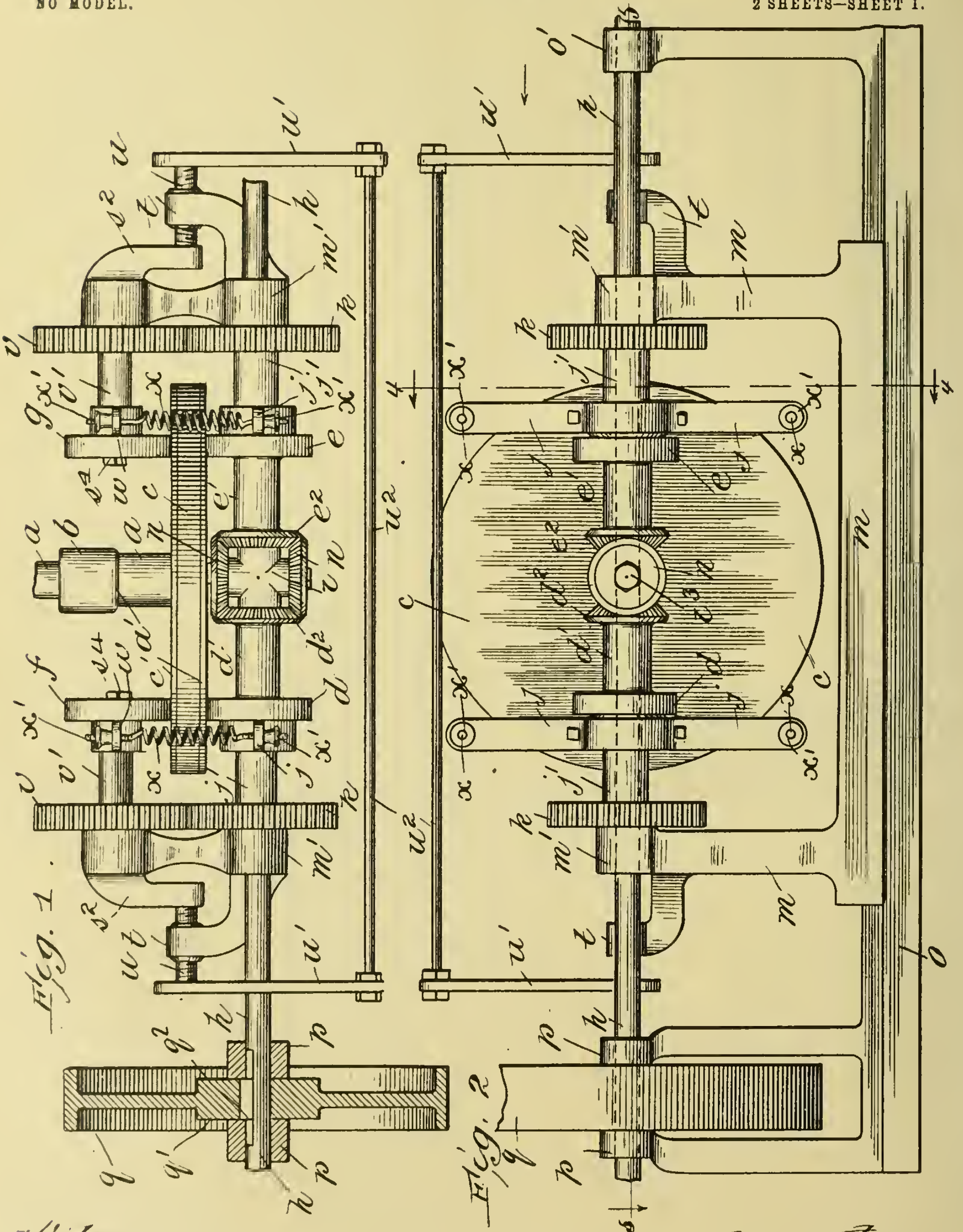
No. 751,564. PATENTED FEB. 9, 1904.

C. E. SARGENT.

VARIABLE SPEED MECHANISM.

APPLICATION FILED MAY 8, 1903.

NO MODEL. 2 SHEETS—SHEET 1.



Witnesses:

Harry R. Schulte

Ray White

Inventor:

Charles E. Sargent.

By Howard M. Cox

Atty.

THE NORRIS PETERS CO. PHOTO-LITHO. WASHINGTON D.C.

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No. 751,564. PATENTED FEB. 9, 1904.

C. E. SARGENT.

VARIABLE SPEED MECHANISM.

APPLICATION FILED MAY 8, 1903.

NO MODEL. 2 SHEETS—SHEET 2.

Fig. 3.

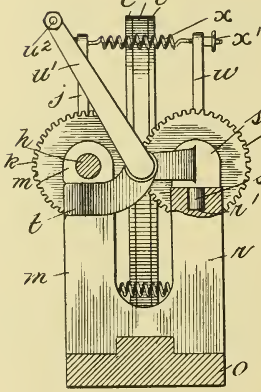


Fig. 4.

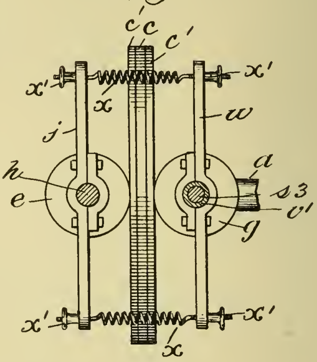


Fig. 5.

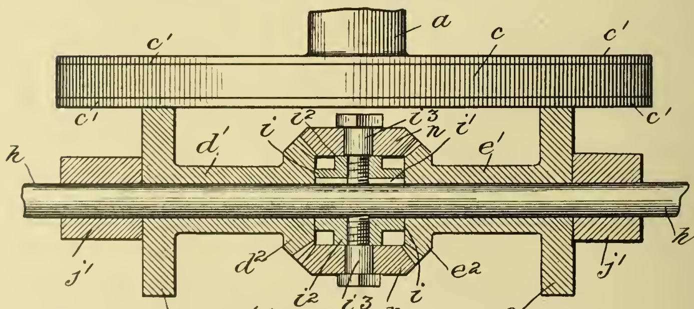
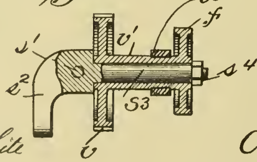


Fig. 6.



Witnesses:
Harry R. White
Ray White

Inventor:
Charles E. Sargent
By Howard M. Cox
Att'y.

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

No. 751,564. Patented February 9, 1904.

United States Patent Office.

CHARLES E. SARGENT, OF CHICAGO, ILLINOIS.

VARIABLE-SPEED MECHANISM.

SPECIFICATION forming part of Letters Patent No. 751,564, dated February 9, 1904.

Application filed May 8, 1903. Serial No. 156,203. (No model.)

To all whom it may concern:

Be it known that I, Charles E. Sargent, a citizen of the United States, residing in the city of Chicago, county of Cook, and State of Illinois, have invented a new and useful Improvement in Variable-Speed Mechanisms, of which the following is a specification.

My invention relates to variable-speed mechanisms wherein power is transmitted from the driving member to the driven member by friction.

It is well understood in connection with friction-gears that the energy which can be transmitted in any given period of time depends on the peripheral speed of the driven friction-roller at the point of contact with the driving-disk, the amount of surface in contact, and the pressure under which the driven surfaces are held in contact.

The object of my invention is to provide a gear in which the power-transmitting factors above enumerated shall be large compared to the size of the mechanism. It is also proposed a mechanism in which the power-transmission shall remain substantially constant for all speeds of the driving member.

Another object of the invention is to provide means whereby the speed may be easily and quickly varied or reversed, while the driving-disk maintains a constant speed in the same direction, and finally the invention contemplates the construction of a mechanism which shall be compact and composed of few parts simply constructed.

I attain these objects by the mechanism illustrated in the accompanying drawings, in which—

Figures 1 and 2 are plan and side views, respectively, of the complete mechanism. Fig. 3 is an end view thereof looking in the direction of the arrow, Fig. 2. Fig. 4 is similar to Fig. 3, but is in section, taken on the line 4 4, Fig. 2. Fig. 5 is a plan view drawn to an increased scale and taken chiefly in section on the line 4 4, Fig. 2. Fig. 6 is a detail view chiefly in horizontal central section through the axis of the rear friction-spindles.

Similar letters refer to similar parts throughout the several views.

Referring to the drawings, *a* represents a driving-shaft journaled in a fixed bearing *b*. A shoulder a' is formed upon said shaft to abut against said bearing to limit the end play of said shaft therein. At the extremity of said driving-shaft is rigidly fixed the driving-disk *c*, which is desirably provided upon its front and rear surfaces with the facings c' c', of leather or other suitable material, for driving the friction-rollers *d*, *e*, *f*, and *g*. The rollers *d* and *e* are formed upon the hubs d' and e', respectively, and there are also formed on said hubs the bevel gear-wheels d^2 and e^2, respectively.

h represents the shaft to be driven, and it has a fixed axis extending at right angles to and located substantially in the same plane as the axis of the driving-shaft *a*.

The hubs d' and e' are each loosely mounted on said shaft and are prevented from sliding thereon by means of the hubs *i*, located between them, and by means of the yoke-arms *j j*, loosely mounted on said shaft at the outer extremities of said hubs d' and e'. Said yoke-arms are in turn laterally confined by means of the spacing-rollers j' j', located between hubs d' and e' and the gears *k k*, which latter are keyed to said shaft *h*.

On the hub *i*, which is secured to shaft *h* by means of the key i', are formed the bosses i^2 i^2, which receive and securely hold the threaded inner extremity of the studs i^3. Said studs are arranged at right angles to the axis of shaft *h* and form axles for the bevel-gears *n n*. Said gears are loosely mounted, so as to revolve upon said studs j^3 and intermesh simultaneously with the gears d^2 e^2. The diameter of the gears d^2 and e^2 are equal, and the diameter of the gears *n* are equal, and by preference all of the said gears are miter-gears. The gears d^2, e^2, and *n* thus form a differential mechanism, and it follows that when gears d^2 and e^2 rotate at the same speed in opposite directions the gears *n* will rotate about their axes on the studs i^3; but said studs will have no rotary motion about the shaft *h* as an axis. When, however, the gears d^2 and e^2 rotate at different speeds, the gears *n* and studs i^3 will be caused to rotate about shaft *h* as an axis, the direction of rotation depending upon which of the gears d^2 or e^2 is for the time being the faster moving. The rotation of said studs about the shaft h as an axis will cause a corresponding rotation of the hub i, and consequently of said shaft h.

The rollers d and e are of the same size, and consequently when they are equidistant from the axis of the driving-shaft a the gears d^2 and e^2 will rotate at the same speed, and there will be no rotation of the studs i^3; but when said rollers are at unequal distances from the axis of said driving-shaft the gears d^2 and e^2 will rotate at different speeds, and there will be imparted to said studs a rotary motion about the shaft h. Thus the direction of the motion of studs i^3 will correspond to the direction of rotation of such one of the rollers d or e as is temporarily located at the greater distance from the center of said driving-shaft a. It is evident, therefore, that the speed and direction of rotation of studs i^3 about the shaft h may be controlled by shifting said friction-rollers along the shaft h.

The shifting of the friction-rollers d and e and connected parts is accomplished by means of the carriage m, which has bearings m' m' encircling the shaft h at the outer side of the gears k. The carriage-guide o extends parallel to the shaft h, so that said carriage is guided partly by said guide o and partly by the shaft itself. Said shaft is journaled in the fixed bearings o' and p p in such manner as to be laterally shiftable therein. By preference said bearings o' and p are rigidly connected to said carriage-guide o.

In the present instance the transmitted energy is imparted by shaft h to the band-wheel q, the hub q' whereof is confined between said bearings p, and thereby prevented from moving laterally. In order that said band-wheel may not prevent the lateral shifting of the shaft h, a spline or feather q^2 is seated partly in the shaft h and partly in said hub q'.

The parts of the mechanism thus far described are operative in themselves to transmit motion from the driving-shaft a to the driven shaft h and obtain both variation in speed and change of direction of said shaft h without change of speed or direction of the driving-shaft a; but by employing the additional parts hereinafter described a greater area of friction-surfaces is rendered readily available.

The carriage m has two standards r r formed thereon, and these support the pivot-blocks s. The preferred construction is shown in Fig. 3, s' representing a pivot-pin fixed to the block s and rotatably held in the socket r' in the standard r. The arms s^2 are formed on said pivot-blocks so as to extend toward the shaft h. The brackets t are formed on the carriage m near the bearings m' thereon and extend toward said pivot-blocks s. The extremities of said brackets t are threaded to receive the releasing-screws u. The inner extremities of said screws bear against the adjacent extremities of the arms s^2 of the pivot-blocks, and the parts are so arranged that when said screws are rotated in the direction toward said arms the pivot-blocks s will be rotated about the pins s' as an axis. Said screws are rotated by means of the arms u', which are rigidly secured thereto. Said arms u' are parallel and are connected at their extremities by means of the controlling-bar u^2. The screws u have a coarse thread, so that a slight rotation will produce a comparatively large movement of the screws transversely to the brackets t. In the arrangement shown one of said screws has a left-hand thread and the other a right-hand thread, so that when the controlling-bar u^2 is rotated the pivot-blocks s will rotate in opposite directions.

Projecting inwardly from the blocks s are the spindles s^3, whereon the gears v and friction-rollers f and g are loosely mounted. Said gears and friction-rollers are secured to and preferably form an integral part of the hubs v', so as to rotate together. Said gears v and their friction-rollers are held in position on said spindles s^3 by means of the nuts s^4. The parts are so arranged that under normal conditions the gears v will mesh with the gears k and the rollers f and g will make frictional contact with the rear surface of the driving-disk c. Inasmuch as the gears v and k intermesh, the power received by the rollers f and g will be transmitted through said screws to the shaft h to rotate the same. Thus the gears f and g practically double the tractive force of the mechanism—that is to say, the amount of power which can be transmitted from the driving-shaft to the driven shaft.

In order that the friction-rollers f and g may under normal conditions make close contact, the yoke-bars w w are loosely mounted on the hubs v' adjacent to the friction-rollers f and g. Said yoke-bars w and also the yoke-bars j, above mentioned, extend vertically and are joined at their extremity by means of the tension-springs x. Said tension-springs have threaded extremities penetrating the apertured extremities of said yoke-bars j and w and carry outside of said yoke-bars the nuts x', whereby the tension of said springs may be adjusted. The length of the bars j and w is sufficient to permit the springs x to clear the driving-disk c. There is a slight amount of end play of the shaft a in the bearing b, so that under normal conditions there will be a self-adjustment of said disk, with the result that the friction-rollers on opposite sides of the disk will be held in contact therewith under equal pressures. The slight end play of shaft a in its bearing is also useful, for the reason that when the friction-rollers f and g are withdrawn from contact with the driving-disk the pressure between the said driving-disk and the disks d and e will be reduced sufficiently to permit said rollers *d* and *e* to be shifted along the face of said driving-disk.

In operation the driving-disk is supposed to rotate in the same direction and at the same speed at all times.

When the rollers *d* and *e* are equidistant from the axis of shaft *a*, there will be no rotation imparted to the shaft *h*. When the roller *d* is at a greater distance from the axis of shaft *a*, said shaft *h* will rotate in one direction, and when the roller *e* is at a greater distance from the axis of shaft *a* said shaft *h* will rotate in the opposite direction, and the speed of rotation of said shaft *h* will increase as the distance of the farthest friction-roller from the axis of the driving-shaft increases.

Under normal conditions the tension-springs *x* will hold the rollers *d*, *e*, *f*, and *g* in close contact with the driving-disk *c*, any desired pressure being obtained by adjusting the tension of said springs by means of the adjusting-nuts *x'*.

When it is desired to change the speed of shaft *h* or vary its direction of rotation, the rollers *f* and *g* are forced away from the driving-disk *c* by rotating the controller-rod u^2 in the proper direction to force the screws *u* toward the arms s^2 on the pivot-blocks *s*. Only a slight motion of said pivot-blocks is necessary to withdraw the rollers *f* and *g*, this motion being insufficient to cause the gears *r* to be disengaged from the gears *k*. When the rollers *f* and *g* have thus been withdrawn and the driving-disk *c* released, said driving-disk will retreat slightly from the rollers *d* and *e*. The carriage *m* and parts mounted thereon are then shifted laterally until the rollers *d*, *e*, *f*, and *g* are brought to such distances from shaft *a* as to obtain the speed and direction desired for shaft *h*. The bar u^2 is then thrown back to its normal position, with the result that the screws *u* are retracted from the arms s^2 and the springs *x* are again permitted to hold the friction-rollers in close contact with disk *c*.

This mechanism may be employed for a variety of uses; but it is particularly well adapted for use in automobiles, where it is desirable to transmit high driving powers, but where the available space is restricted. In this mechanism the speed may be controlled from the single bar u^2, the rotary motion or swinging motion of the bar causing the driven shaft to stop and the shifting motion of said bar obtaining the desired direction or speed of rotation.

Another use for which this mechanism may be employed to advantage is in lamp-controllers for photographic-printing apparatus, such as that shown in a companion application for Letters Patent filed by me on even date herewith.

I do not wish to be understood as limiting myself to the particular design of the mechanism as herein shown, for this may be greatly varied without departing from the spirit of my invention.

What I claim as new, and desire to secure by Letters Patent, is

1. In a variable-speed mechanism, the combination of a driving-disk; a pair of friction-rollers adapted to contact one surface of said disk on opposite sides of the axis thereof; and a second pair of friction-rollers adapted to contact the other surface of said disk on opposite sides of the axis thereof; connections between the rollers which lie upon the same side of the disk-axis whereby said rollers supplement each other in their power-transmitting effect; a driven member; and differential gear connections between said driven member and one of said pairs of rollers.

2. In a variable-speed mechanism, the combination of a driving-disk; a pair of friction-rollers adapted to contact one surface of said disk on opposite sides of the axis thereof; and a second pair of friction-rollers adapted to contact the other surface of said disk on opposite sides of the axis thereof, connections between the rollers which lie upon the same side of the disk-axis whereby said rollers supplement each other in their power-transmitting effect; a driven member; differential gear connections between said driven member and one of said pairs of rollers and means for shifting all of said rollers simultaneously along the surfaces of said disk to thereby vary the speed of said driven member.

3. In a variable-speed mechanism, the combination of a driving-disk; two sets of friction-rollers, the rollers of each set being located in position to contact said disk on the same side of the disk-axis but on opposite surfaces of said disk, and the rollers of each set being geared together for supplementing each other; a driven member; a differential mechanism connecting said rollers to said driven member for driving the latter; and means for moving said rollers toward and from said disk.

4. In a variable-speed mechanism, the combination of a driving-disk; two sets of friction-rollers normally held in contact with said disk, the rollers of each set being located in position to contact said disk on the same side of the disk-axis, but on opposite surfaces of said disk, and the rollers of each set being geared together to supplement each other; a driven member; a differential mechanism connecting said roller to said driven member for driving the latter; and means for releasing said rollers from said disk.

5. In a variable-speed mechanism, the combination of a driving-disk; two sets of friction-rollers normally held in contact with said disk, the rollers of each set being located in position to contact said disk on the same side of the disk-axis, but on opposite surfaces of said disk, and the rollers of each set being geared together to supplement each other; a driven member; a differential mechanism connecting said roller to said driven member for driving the latter; means for releasing said rollers

from said disk, and means for shifting all of said rollers simultaneously along the surface of said disk to thereby vary the speed of said driven member.

6. In a variable-speed mechanism, the combination of a driving-disk; a shiftable carriage; a pair of friction-rollers mounted in said carriage in position to contact said disk on the same surface thereof on opposite sides of the disk-axis; a driven shaft; a differential mechanism connecting said rollers to said shaft for driving the same; a second pair of friction-rollers mounted in said carriage and adapted to contact the driving-disk on the remaining surface thereof and gear connections between said first pair and second pair of friction-rollers, whereby said second pair of rollers supplements the action of said first pair of rollers.

7. In a variable-speed mechanism, the combination of a driving-disk; a shiftable carriage; a pair of friction-rollers mounted in said carriage in position to contact said disk on the same surface thereof on opposite sides of the disk-axis; a driven shaft; a differential mechanism connecting said rollers to said shaft for driving the same; a second pair of friction-rollers mounted in said carriage and adapted to contact the driving-disk on the remaining surface thereof for supplementing the action of the first pair of rollers, said second pair of rollers being pivotally mounted to swing toward and from said driving-disk; gear connections between said first and second pairs of rollers; and means for swinging said second pair of rollers toward and from said disk.

8. In a variable-speed mechanism, the combination of a driving-disk; a shiftable carriage; a pair of friction-rollers mounted in said carriage in position to contact said disk on the same surface thereof on opposite sides of the disk-axis; a driven shaft; a differential mechanism connecting said rollers to said shaft for driving the same; a second pair of friction-rollers mounted in said carriage and adapted to contact the driving-disk on the remaining surface thereof for supplementing the action of the first pair of rollers; said second pair of rollers being pivotally mounted to swing toward and from said driving-disk; gear connections between said first and second pairs of rollers; means for swinging said second pair of rollers toward and from said disk; a spring-influenced device for holding said second pair of rollers in frictional contact with the disk; and means for swinging said rollers away from said disk to thereby release the same.

9. In a variable-speed mechanism, the combination of a driving-disk; a shiftable carriage; a pair of friction-rollers mounted in said carriage in position to contact said disk on the same surface thereof on opposite sides of the disk-axis; a driven shaft; a differential mechanism connecting said rollers to said shaft for driving the same; a second pair of friction-rollers mounted in said carriage and adapted to contact the driving-disk on the remaining surface thereof for supplementing the action of the first pair of rollers; said second pair of rollers being pivotally mounted to swing toward and from said driving-disk; gear connections between said first and second pairs of rollers; means for swinging said second pair of rollers toward and from said disk; a screw device for holding the second pair of rollers in frictional contact with the disk and means for swinging said rollers away from said disk to thereby release the same.

10. In a variable-speed mechanism, the combination of a driving-disk; a shiftable carriage; a pair of friction-rollers mounted in said carriage in position to contact said disk on the same surface thereof on opposite sides of the disk-axis; a driven shaft; a differential mechanism connecting said rollers to said shaft for driving the same; a second pair of friction-rollers mounted in said carriage and adapted to contact the driving-disk on the remaining surface thereof for supplementing the action of the first pair of rollers; said second pair of rollers being pivotally mounted to swing toward and from said driving-disk; gear connections between said first and second pairs of rollers; means for swinging said second pair of rollers toward and from said disk; a screw device for holding the second pair of rollers in frictional contact with the disk, means for swinging said rollers away from said disk to thereby release the same and a controlling-rod for operating said screw device.

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